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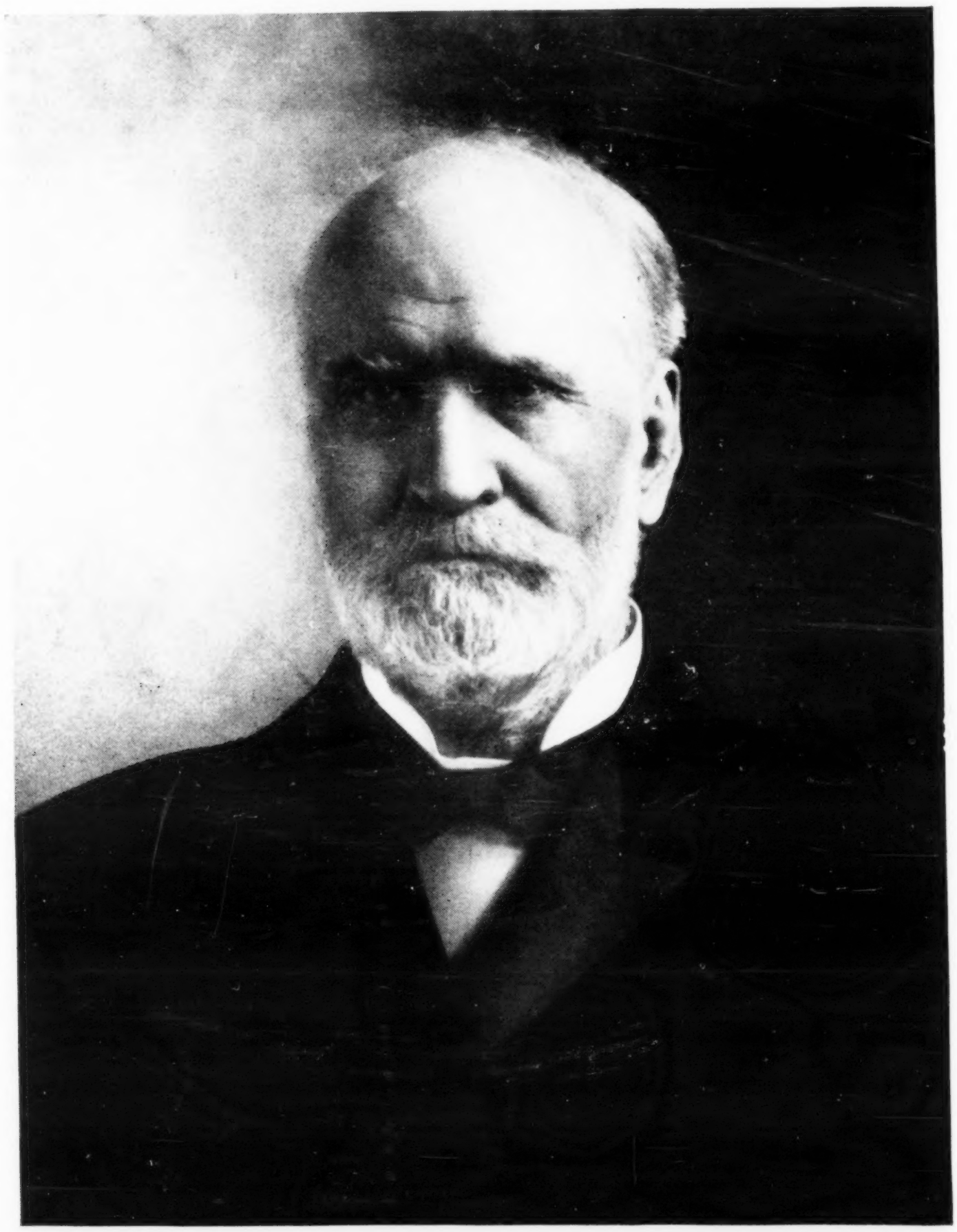

James Wilson

First President of the A. G. A.

"—Is not man, after all, the Architect of his own racial destiny?"

VOLUME 22 JANUARY, 1931 NUMBER 1

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

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The

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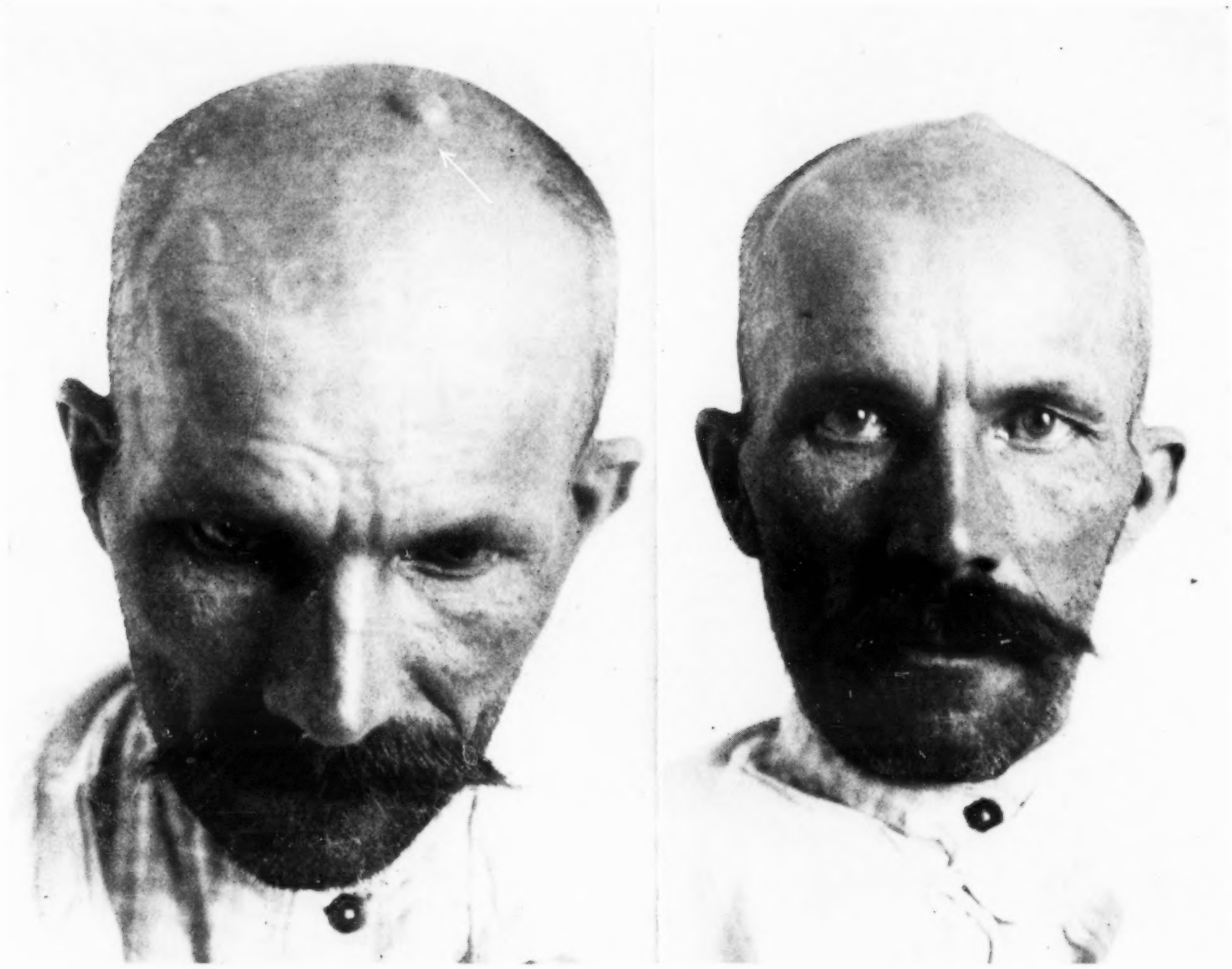

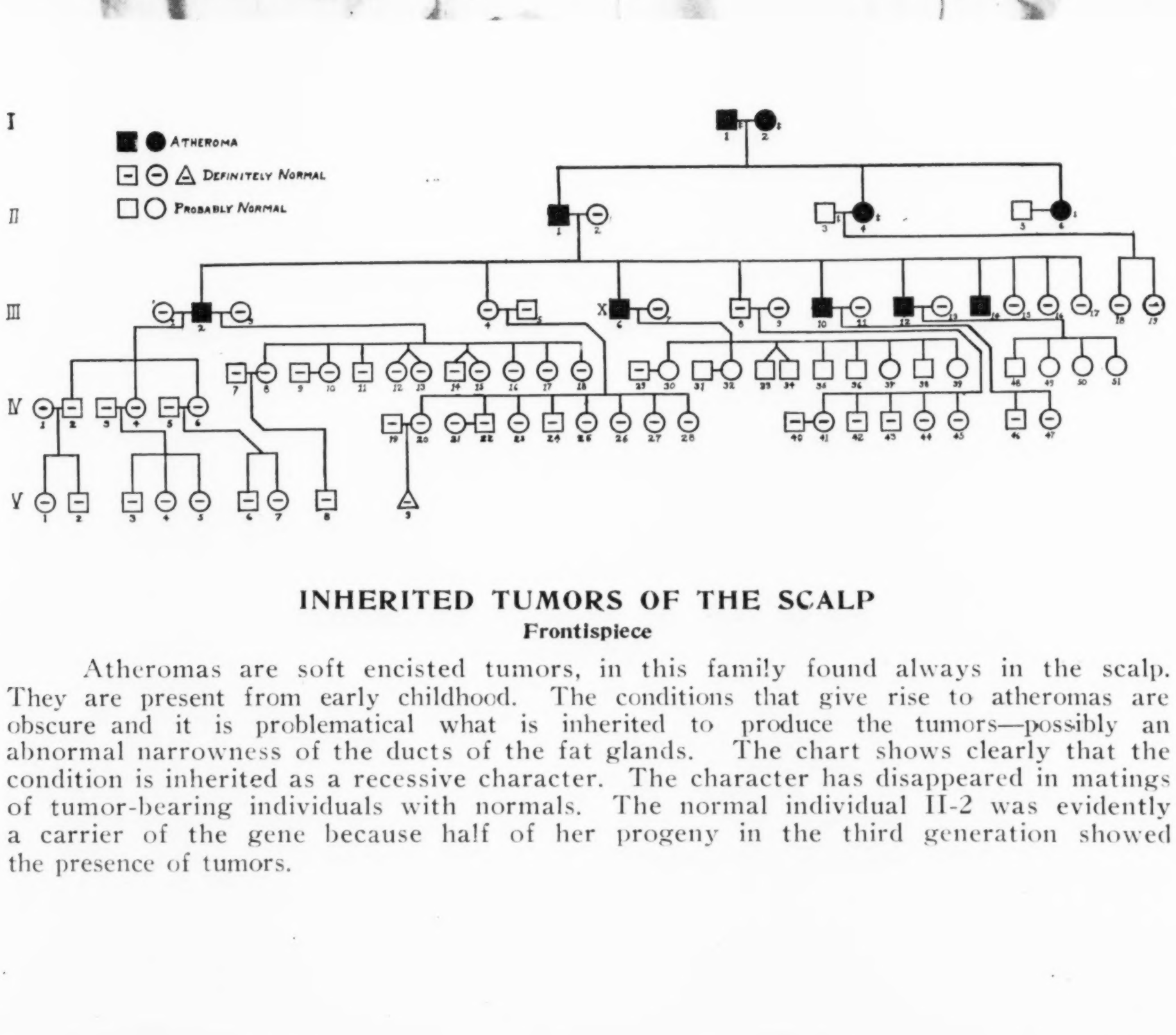

INHERITED TUMORS OF THE SCALP

Frontispiece

Atheromas are soft encisted tumors, in this family found always in the scalp. They are present from early childhood. The conditions that give rise to atheromas are obscure and it is problematical what is inherited to produce the tumors—possibly an abnormal narrowness of the ducts of the fat glands. The chart shows clearly that the condition is inherited as a recessive character. The character has disappeared in matings of tumor-bearing individuals with normals. The normal individual II-2 was evidently a carrier of the gene because half of her progeny in the third generation showed the presence of tumors.

ON THE HEREDITY OF ATHEROMA

S. Levit
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THE heredity of atheroma has been comparatively but little investigated. In the older medical literature we find the bare fact of the heredity of this tumour mentioned by divers authors, but without any explanatory details. The first case that is, more or less, discussed scientifically is the one described by Schneider in 1913: this case (including five generations) shows with sufficient clearness the dominant character of the heredity (with one lapse). According to the data presented by Siemens, who gives the name of genuine atheroma to epidermoids, and pseudo-atheroma to follicular cyst, these last are not hereditary, "with the exception of one particular form (sebaocystomatosis multiplex)." The epidermoids, on the other hand, he considers hereditary, the heredity being of an irregular dominant character. Although this opinion is based on the study of numerous cases (114), it cannot nevertheless be held as quite conclusive, inasmuch as the material used by the author is not quite exact (the data in 109 cases, furnished by letters from patients, whose address the author obtained from the Polyclinic in Munich) and not exhaustive: references are obtained for a very small number of the patients' relatives. Moreover, the conclusion—whether to count a case as an epidermoid or cyst is reached by side issues only which Siemens himself does not consider entirely convincing. All this considered, the case studied by us is interesting not only as illustrating the recessive type of the heredity, but also because it shows that certain mistakes are possible in determining the type of heredity in anthropogenetics.

The case in question is that of a peasant of the village of Novozaretchye, Tchetchersk district, province of Gomel, Nicholas Leonovitch Philipof by name, aged 45. I found an atheroma on the hairy part of his head (Frontispiece). The tumor is round, of firm consistence; it is undetachable from the skin and about 2 cm. in diameter. The patient says this tumor existed from his early childhood (congenital?). The type of the heredity is illustrated by the pedigree here given.

The patient gave at once quite exact information about the existence of similar tumors in his family, confirmed afterwards by letters from his relatives. He could give us information about all persons except two in the second generation, designated under the Nos. 4 and 6. As this case could only be regarded as a hereditary recessive one (under the condition of homozygosity for the pathological factor *aa* for 1 and 2 of generation 1, and of heterozygosity *Aa* for the mother of the patient—II-2), it was surmised that both the aunts of the patient (3 and 5 generation II) must also possess the same character. Thus only could the hereditary transmission be explained in this case:

$$\frac{aa \times aa}{I} \rightarrow \frac{aa,\ aa,\ aa}{II}$$

(the entire second generation must possess this character)

$$\frac{aa \times Aa}{1,\ II \times 2,\ II} \rightarrow \frac{Aa,\ Aa,\ aa,\ aa}{III}$$

(half of the progeny normal and half pathological)

We see from the chart that in the third generation, out of ten persons half really prove to be normal, and half "pathological." The fact that among the IV and V generation we find no persons affected would also be perfectly clear, if a marriage of the

type $aa \times Aa$ had never taken place among their parents (the absence of marriages of the type $aa \times aa$ having been duly ascertained). The relatives of the patient being questioned, confirmed the fact, that 4 and 6 of generation II did have atheromas on the hairy part of the head. Thus, the recessive-autosomal type of the heredity is in this case proved beyond doubt.

This case is interesting from the point of view of pathology, as well as anthropogenetics. First, it is interesting to note that all the patients have the atheroma on the head, the only difference being that I-1 and II-1 had two tumors, I-2 had three, and all the others one each (the grandmother of the patient had a tumor which burst open sometimes, emitting a curd-like substance). It is also to be remarked, that in all cases the atheromas were noticed from early childhood (congenital?). At this point it is interesting to compare our case with the above cited one of Schneider where the heredity follows the dominant type: it is to be regretted that the location of the tumor is not given, but as to the moment of its appearance, it is shown to be in Schneider's case not before the age of 12. These cases differ, consequently, both clinically and genetically. This is an apt illustration of the general idea, that clinical complexes of symptoms, outwardly identical, are often biologically widely separated, and that a more searching investigation might possibly detect clinical divergences as well. In regard to atheroma, which is obviously a non-homogeneous complex of symptoms, whether from a clinical or from an anatomo-pathological point of view, genetical analysis will in all probability be called to take a leading part in the differentiation of its different forms.

It is, further, interesting, that it proved possible to foretell the fact of a definite affection in the case of two persons, without having seen them and not knowing anything about them, on the strength of genetical inferences alone,—a fact that was later on completely confirmed.

The question—what is it precisely, that is inherited in the given case?—is a difficult one to answer with certitude, the pathogenesis of the atheroma not being as yet fully explained. Still, if we adopt the current theory of the atheroma as a retention cyst it can be admitted that what is inherited is an abnormal narrowness of the excretory ducts of the fat glands, which, perhaps combined with some additional agent, leads to the phenotypical formation of a tumor in some definite place.

But the case mentioned is interesting also from a genetical point of view. The peculiarity of the genealogical table (Frontispiece) strikes the observer from the first glance; all the members of F_1 and F_2 possess the character in question, and half of the members of F_3 also, while it disappears totally in all the numerous F_4 and F_5. Again, the case under discussion is a good illustration of the impossibility of judging of the type of heredity by a small number of generations. Thus, in the case we are speaking of, if we had known but three generations, or only a few of the patients descendants of the III generation, the number of children of the normal F_3 being unlimited, we might have defined the heredity either as dominant or recessive. Only the knowledge of the numerous F_4 and F_5 gives a clue to the right solution.

Lastly, the genogeography of the case is interesting. It must here be noted that the grandfather and grandmother of the patient (I-1, 2) were born and spent their life in the village of Sebrovitchi (5 km. distant from the village of Novozaretchye, where the patient lives); while his mother (II-2; maiden name Mankof), a heterozygote, comes from the village of Zalessye, 15 km. from Sebrovitchi. If we note that both the parents of the grandfather as well as of the grand-

mother of the patient were also bearers of this gene—at all events in heterozygous state, we are led to infer that in the given region (in a radius of 15 km.) five persons at least were bearers of this gene in a non-apparent state. If we then turn to the numerous F_4 and F_5 some of the members of which are also shown to be heterozygous (all of them having remained in the same region), we must conclude that the region in question is well saturated with the gene described. An investigation of the entire population of the region by the local physicians in respect to atheroma would therefore be of interest, from the point of view of genogeography.

Literature Cited

1. Schneider, Hans. 1913. *Muench. Med. Woch.*
2. Siemens, H. W. 1923. *Arch. d. Dermat. v. Syph.* Vol. 144.

James Wilson (1835-1920)

HON. JAMES WILSON, under whose Secretaryship the Department of Agriculture first became an organization for scientific research, was first president of the American Genetic Association (Organized in 1903 as the American Breeders' Association). The new Association owed its origin, in fact, to a committee appointed some months earlier at the suggestion of Secretary Wilson, by the American Association of Agricultural Colleges and Experiment Stations.

On his retirement from public life in 1913 Secretary Wilson also withdrew from the presidency of the Association. His retiring address, delivered at Charleston, S. C., expressed his pride in the accomplishments of the Society, and in the following words his belief in the way in which the Association would be of greatest ultimate value:

> A new line of public service has recently developed which promises more far-reaching results than those relating to improvements through breeding: The work of our agricultural research institutions has demonstrated that we can slowly but surely and very economically increase production by finding those best families, strains, varieties, breeds, and sub-breeds which yield the largest net profits per acre or per farm, and multiply them so that they will supplant all inferior forms. To so educate, place in position of advantage, and reward the best part of the human race that they will rapidly multiply and become the great improved body of people which can best utilize the opportunities of this beautiful earth at first seems like an Utopian vision. Like world peace, however, it may come; and may we not all ask: Why should it not come? Must science stop in its beneficence with the plant and animal? Is not man, after all, the architect of his own racial destiny? Cannot the best people of the best races be wise enough to multiply and become dominant in numbers as well as in efficiency and goodness?

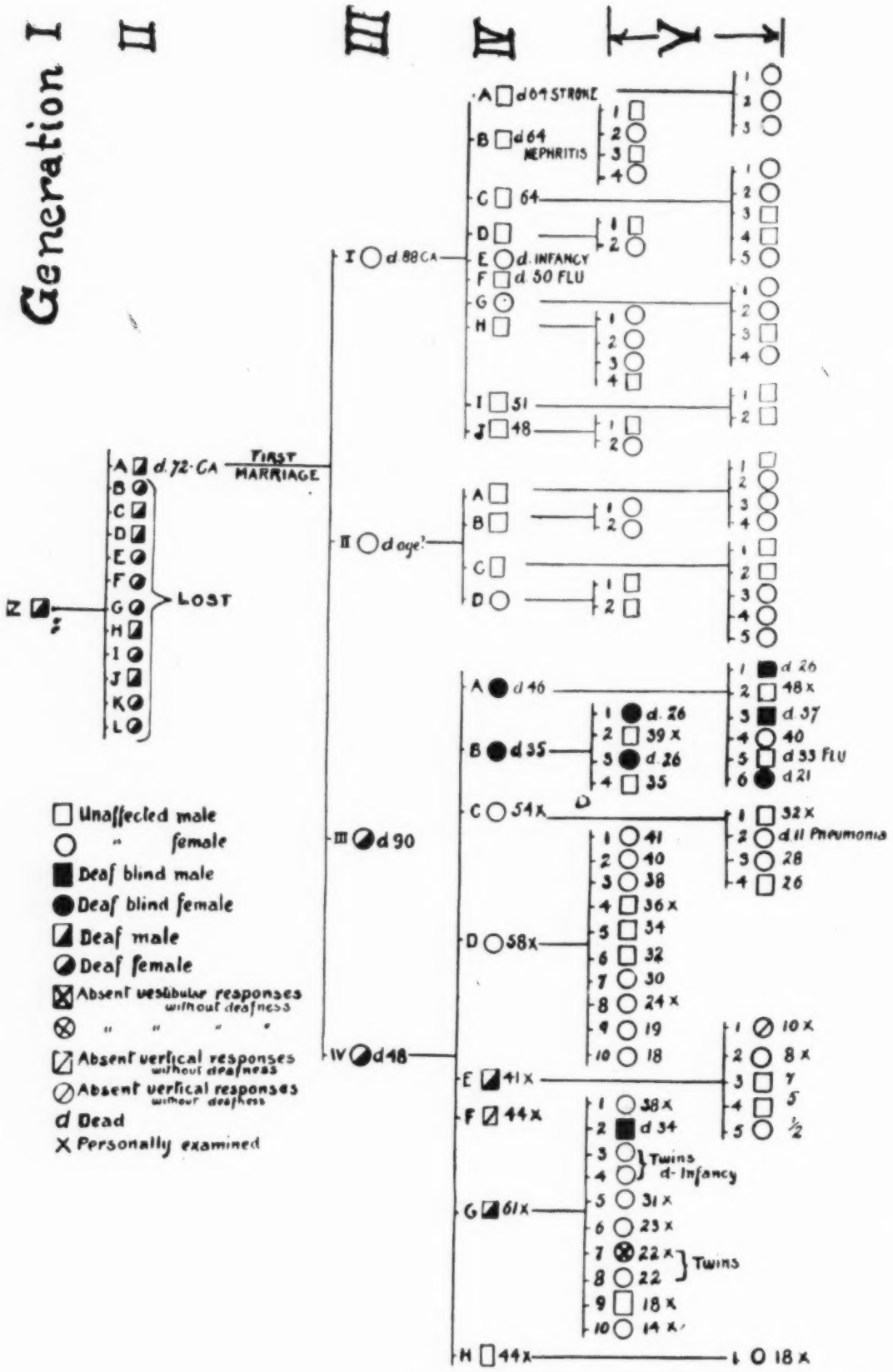


Figure 1

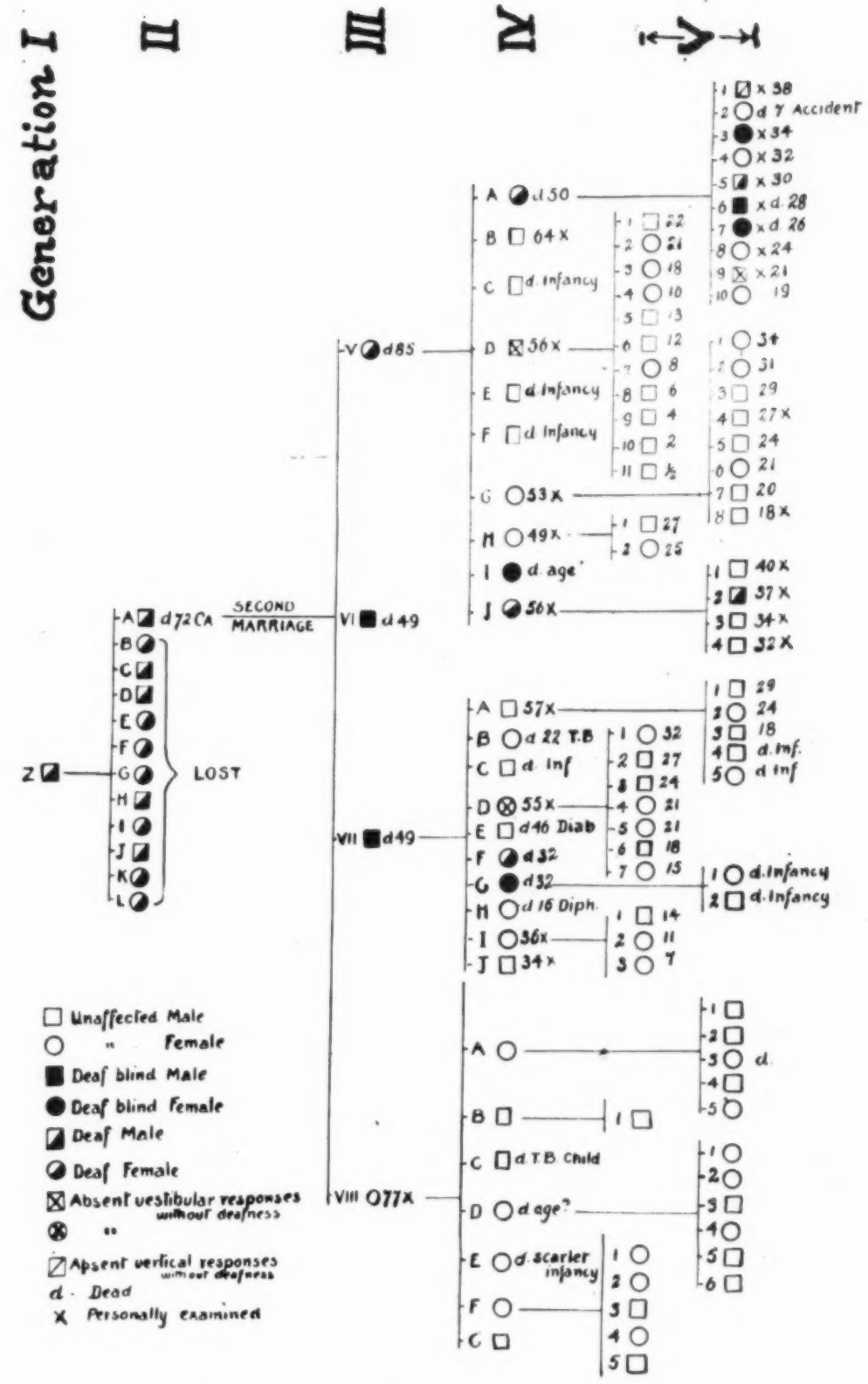


Figure 2

INHERITANCE OF TUMORS OF THE ACOUSTIC NERVE

The first generation is represented by Z, the second by A to L, the third by Roman numerals, the fourth by capital letters and the fifth by figures. The fifth generation is indicated by a double column. The ages, when known, are placed after the symbols. For the sake of simplicity, the issue of the two marriages of ZA are separated. The cause of death, when known, is indicated.

In Figure 2 the first two generations seen in Figure 1 are duplicated.

HEREDITARY BILATERAL ACOUSTIC TUMORS*

A Survey of a Family of Five Generations with Bilateral Deafness in Thirty-eight Members

W. JAMES GARDNER, M. D., *Cleveland, Ohio*
AND
CHARLES H. FRAZIER, M. D., SC. D., *Philadelphia, Pa.*

A PATIENT (V A 6 on Figure 2) was admitted to the neurosurgical service of the University of Pennsylvania Hospital on October 9, 1928, presenting typical signs and symptoms of bilateral tumors of the eighth nerve This patient's history indicated that the condition had been transmitted in his family for five generations. The case aroused considerable interest because bilateral acoustic tumors are exceedingly rare, and no case of familial transmission of such tumors had ever been reported. An investigation of the history of this family was begun, therefore, with the results which are summarized in the accompanying charts.

This condition is one which lends itself easily to clinical investigation because the afflicted person becomes stone deaf. The sequence of events in a case of acoustic-nerve tumor is very definite, chronological, and is readily identified by the trained observer. The first symptom is a ringing sound in the affected ear, which may be accompanied by a slight unsteadiness of gait. After the ringing has persisted for a period of months or years, deafness gradually develops. The ringing and deafness indicate that the tumor is pressing on the auditory portion of the eighth nerve, and the slightly unsteady gait is indicative of involvement of the vestibular or equilibratory portion of the nerve. As the tumor continues to enlarge, it causes pressure on the cerebellum, resulting in more marked ataxia. It also produces a generalized increase in intracranial pressure, resulting in headache, vomiting, and failure of vision. This last symptom is the result of swelling of the optic nerve as the result of increased intracranial pressure, and can be recognized easily by an examination of the eyegrounds. If the tumor is growing very slowly, it may never attain sufficient size to cause an increase in the intracranial pressure, so that the patient may go through life with only deafness as an indication of his trouble.

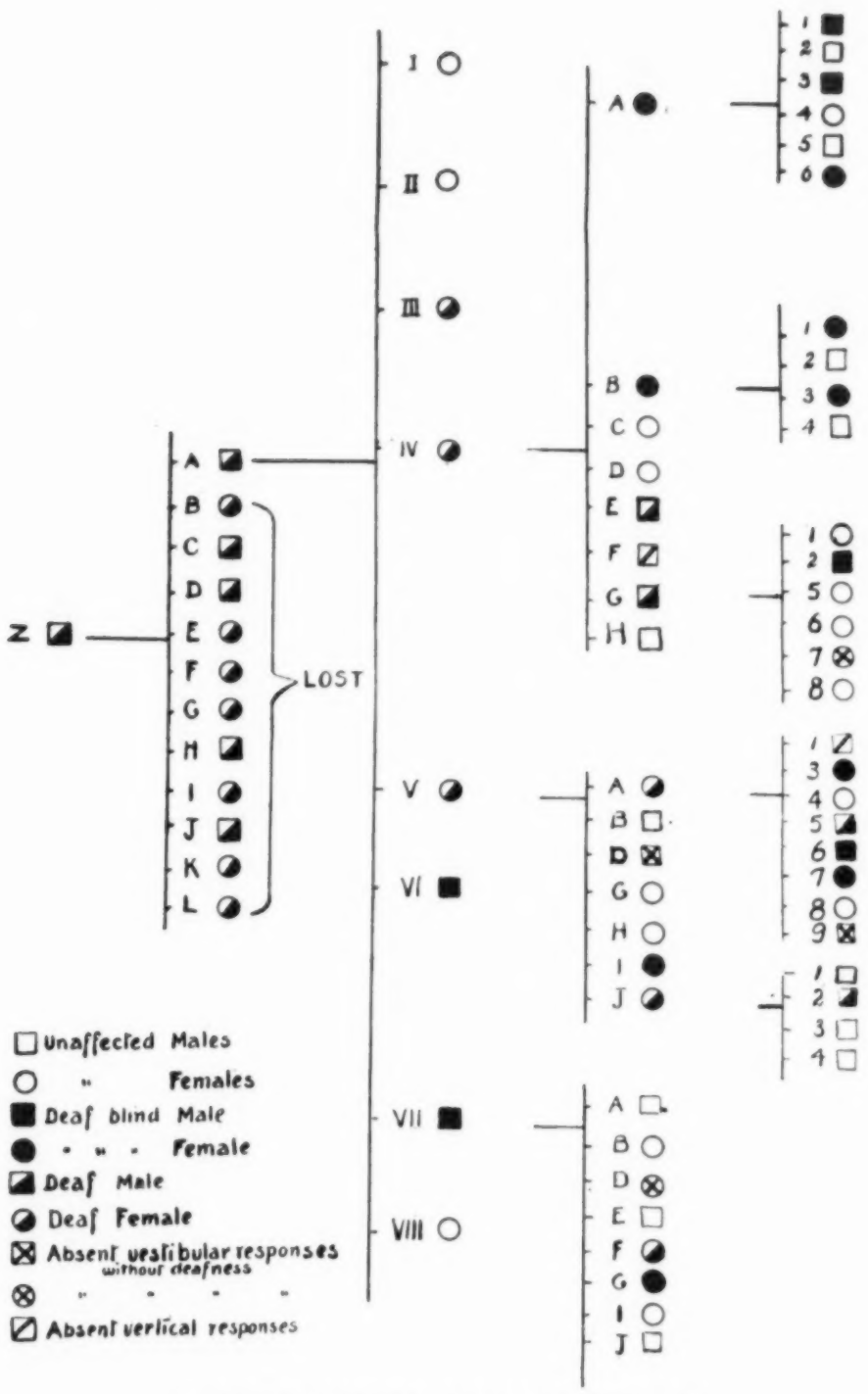
Post mortem examinations of patients with incipient acoustic tumors indicate that these lesions originate on the vestibular portion of the eighth nerve and that the auditory portion is involved secondarily.† Clinically, therefore, in early cases the vestibular tests of Bárány will indicate interference with the vestibular fibers before there is any noticeable loss of hearing.

In investigating the history of this family it has been possible to trace the issue of only one out of twelve members of the second generation (Figures 1 and 2). The information concerning the first two generations is rather scanty, and was furnished by the only living member of the third generation (VIII, Figure 2). These data, therefore, are open to

In Figure 2 the first two generations seen in Figure 1 are duplicated.

*From the Neurosurgical Department, University of Pennsylvania Hospital, Philadelphia. Read at the Fifty-fifth Annual Meeting of the American Neurological Association, Atlantic City, N. J., May 27, 1929. Published in detail in the *Archives of Neurology and Psychiatry,* 23:266-300, February, 1930.

†1. HENSCHEN, F. Zur Histologie und Pathogenese der Kleinhirnbrückenwinkeltumoren. *Arch. f. Psychiat.,* 56:21, 1915.

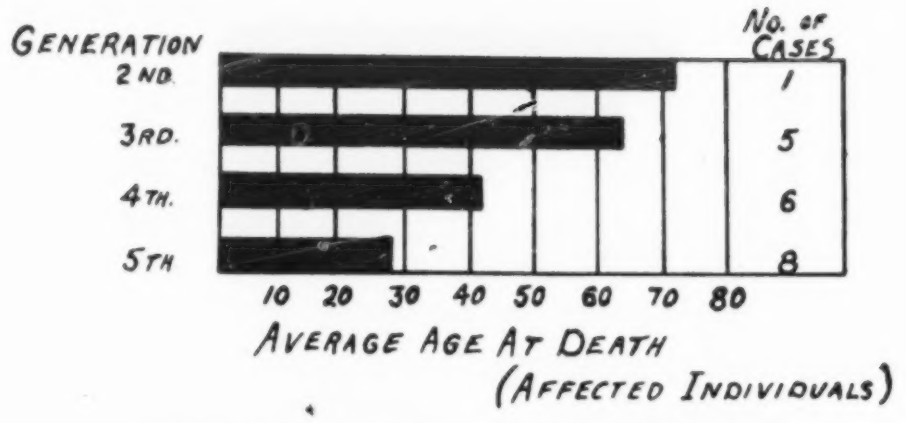


AFFECTED PROGENIES

Figure 3

This chart includes only the susceptible individuals; that is, the children of affected parents who attained the age of twenty years, at which average time the condition became manifest.

question. The data regarding all the other members of the family, however, were obtained either from personal examination or from various other reliable sources. The condition has been transmitted as a true mendelian dominant, as may be seen readily by consulting the charts. If the statement that all members of the second generation were deaf is accepted as a fact, it must be assumed that the paternal parent carried a "double dose", so to speak, of this dominant gene, which occurred in his germ plasm either by inheritance or as a mutation. In no case was the disease transmitted by an unaffected parent.



MALIGNANCY INCREASING

Figure 4

This chart illustrates the increasing malignancy of the disease.

In the fifth generation the average age of onset of deafness was twenty years. Unfortunately, the age of onset in the previous generations could not be determined with any degree of accuracy.

The chart shown in Figure 3 represents only the children of affected parents, who attained the age of twenty years. The total number of members who reached this age in the third, fourth, and fifth generations was fifty-nine. Of this number, the Bárány test showed absent vestibular reactions in four members who had little or no impairment of hearing, thus indicating incipient tumors. Ten were bilaterally deaf, and fifteen were deaf and blind, indicating the presence of fully developed tumors. Thus, of 59 members whose reports were available, 29 were affected. These figures, therefore, almost exactly meet the requirements of a true mendelian dominant; namely, that half the children of an affected heterozygous parents should be affected likewise.

The histological structure of these tumors, their bilateral occurrence, and their increasing malignancy (see Figure 4) suggest the diagnosis of neurofibroma of the von Recklinghausen type. However, none of these individuals exhibited the skin manifestations present in von Recklinghausen's disease, and in the two cases which came to necropsy there were no tumors elsewhere than on the acoustic nerves.

LINKAGE STUDIES IN SHEEP

BORIS WASSIN

The Central Station for Animal Genetics, U. S. S. R.

GENETIC study in live stock is more slow than in insects or in small laboratory animals. This is easily understood, since our live stock animals have a long period of pregnancy, come to maturity only after many months and often have only one young in a litter.

Besides, the study of linkage in them is difficult because of the great number of chromosomes and the insufficient number of known hereditary characters. Only thus is it possible to explain that no case of linkage in live stock has yet been described.

This paper presents the results of matings which were undertaken in an attempt to determine the linkage relation between three heritable characters in sheep; additional nipples, wattles and "necklace."

We give a brief description of these characters and the symbols used by us:

N—additional nipples.

We assume that the basic number of the nipples in sheep is two. A greater number of nipples often found in sheep depends upon the presence of a dominant gene *N*, which increases the basic number to four. The manifestations of this gene are very variable, ranging from the appearance of only one additional nipple resembling a little wart to the appearance of two additional nipples, which are nearly as large as the basic nipples. It is possible that the size of the additional nipples depends on the action of some other genes; for example, all fleshy breeds of sheep possess the most highly developed additional nipples. On the other hand there is a gene (I^n) which inhibits completely the manifestation of the gene *N*. Further increase of the number of nipples up to eight depends on the action of other genes, but these genes are not definitely known. All additional nipples in sheep are placed in front of the basic pair and they are only rarely functional. The normal number of nipples (2) is designated by *n*.

W—The presence of wattles on the neck (designated by *W*).

This is a simple and usually well manifested dominant character. About three per cent of sheep which possess this gene have only one wattle on the right or the left side of the neck. Therefore it is possible that about 1% (3% × 3%) of sheep which have this gene *W* may be phenotypically without wattles. Such a ram was found by us—it had no wattles, but when it was mated with some ewes also without wattles, one-half of its lambs showed this character.

Pn—The symbol for piebaldness in the form of a white stripe around the neck—a "necklace."

This is also a simple dominant character which was found only in the black sheep. The heterozygous animals sometimes show a white stripe interrupted behind the ears.

In order to study the linkage relations we used the ram N 105 which was heterozygous for these three characters. This ram was obtained from the mating ♂ 2 (Merino) and ♀ 24 (Valachian):

Parents

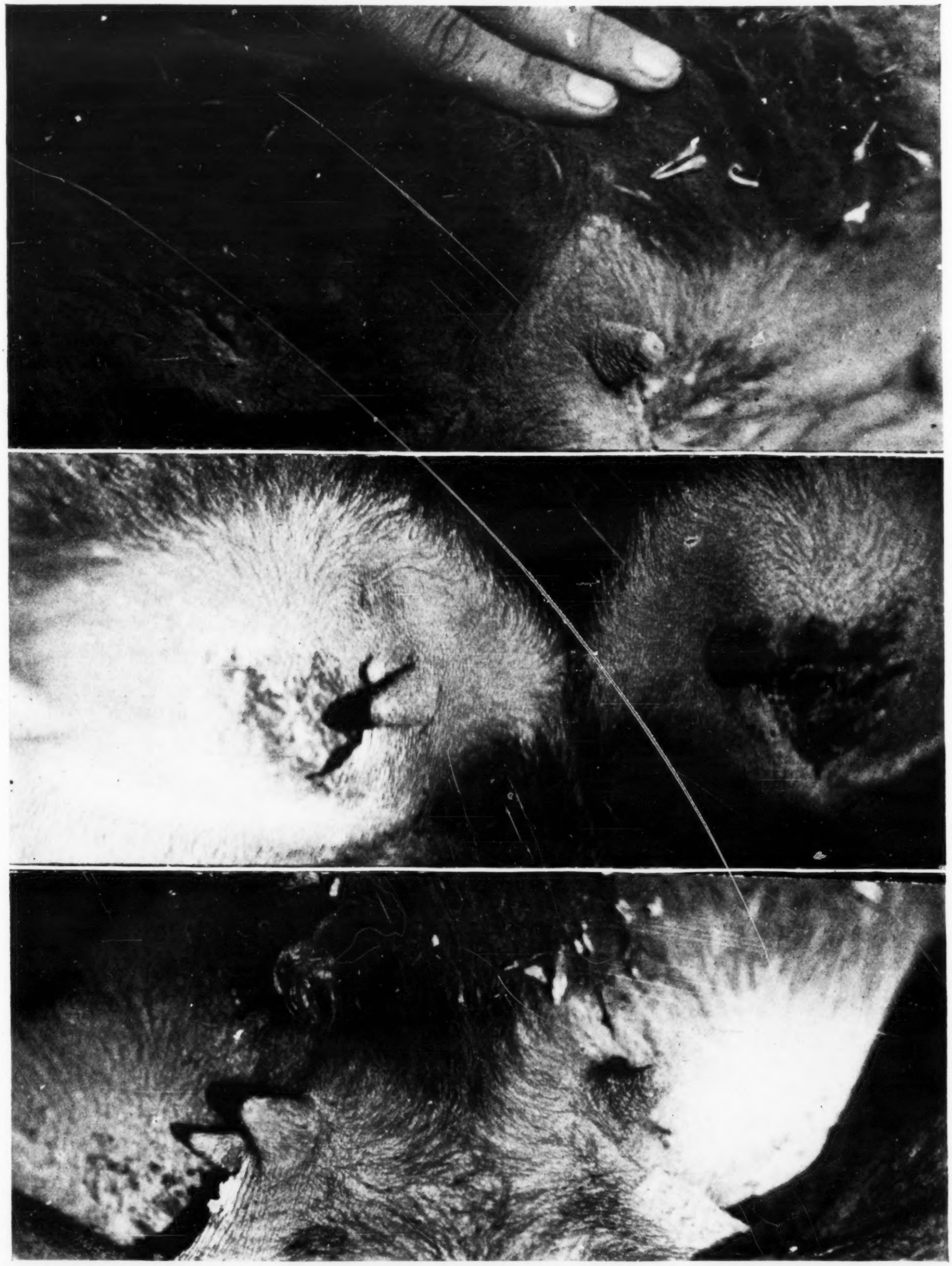
♀ 2 × ♂ 24

nn ww pnpn × *N(N) W(W) Pn(Pn)*

Offspring

♂ 105 *Nn Ww pnPn*

During some years the ram N 105 was mated with 13 ewes which have none of these dominant characters (*nn ww pnpn*) and with 11 ewes which possessed only one dominant character (*Nwpn, nWpn,* or *nwPn*). If we are to examine the relation between one pair of characters *NW, NPn,* or *WPn,* all lambs must be di-



PRIMARY AND SECONDARY NIPPLES

Figure 5

Above—The normal number of nipples in sheep is a single pair. *Center*—Very small secondary nipples. *Below*—Large secondary nipples. Additional nipples are conditioned by a dominant gene, *N*, which increases the basic number to four. Its manifestations are variable, due probably to the existence of modifying factors.

THE NECKLACE PATTERN

Figure 6

This dominant pattern character can be seen only in black sheep. In heterozygous animals the white stripe is sometimes interrupted behind the ears.

vided into four groups. In the first group must be included the lambs which possess both the dominant characters, in the second those which possess none, in the third and in the fourth the lambs which possess only one of these two dominant characters. In the case of linkage the two former groups are the noncrossovers and the latter two are crossovers. In this paper we have determined the percentage of crossing-over by calculating the percentage of the crossover lambs to the number of all lambs obtained in a given mating.

When the ram N 105 was mated with the ewes *nnww* the distribution of lambs obtained from this mating was:

NW — 8 *nw* — 9	17	noncrossovers
Nw —12 *nW* —10	22	crossovers

WATTLES—A DOMINANT CHARACTER

Figure 7

Occasionally wattled sheep have only a single wattle, and a few non-wattled sheep transmit wattles.

In this case the percentage of crossingover was 56.4.

In mating with the ewes *nn pnpn* this ram sired the following lambs:

NPn	— 5	9 noncrossovers
npn	— 4	
Npn	— 5	10 crossovers
nPn	— 5	

In this case the percentage of crossingover is equal 52.6.

In mating with ewes *ww pnpn* this ram sired the following lambs:

WPn	— 4	10 noncrossovers
wpn	— 6	
Wpn	— 5	13 crossovers
wPn	— 8	

i. e., the percentage of crossingover is equal 56.6.

From these data, where the per cent of crossingover exceeds 50 it is possible to conclude that there is no linkage between these three genes and that they are probably located in different chromosomes.

In addition to the characters *N*, *W* and *Pn* these matings gave data on the linkage relation between two of these characters and white color.

The dam of the ram N 105 (♀ 24) was heterozygous for the dominant black color (*Dd*), the sire of this ram (♂ 2) was homozygous for the white color (*CC*); the ram N 105 was white colored.

When it was mated with the ewes possessing the recessive black color, some of its lambs showed black coloring. From this we conclude that the ram N 105 was heterozygous for white

color and that *d* is not identical with *C*. From the recessive black ewes were born 40 lambs: 29 black and 11 white. If here took place a segregation in the ratio 1:1, we must have expected theoretically 20 ± 2.13 black and white lambs; in this case the obtained ratio differs from 1:1 by 4.22 times its probable error. The ratio 29:11 is more close to ratio 3:1; the last ratio must be obtained when the white color depends upon the action of two dominant complimentary genes. All our previous matings of rams heterozygous for white with recessive black ewes gave approximately the same ratio.

Because the ram N 105 was heterozygous for white there is a possibility to test the linkage relation of this coat color to two of the three other characters, viz., additional nipples and wattles. Its relation to the third character "necklace" can not be seen in this mating because this character can not be distinguished in the white sheep.

The ram N 105 obtained the white color from its sire and the additional nipples and wattles from its dam and therefore we must expect here a repulsion.

When the ram N 105 was mated with ewes *cc nn* (recessive black without additional nipples) it gave the following progeny:

Cn	— 6	20 noncrossovers
cN	—14	
CN	— 5	14 crossovers
cn	— 9	

The percentage of crossingover is equal to 41.2.

When this ram was mated with the ewes *cc ww* the progeny were:

Cw	— 8	24 noncrossovers
cW	—16	
CW	— 3	15 crossovers
cw	—12	

In this case the percentage of crossingover is equal to 38.5.

From these data it can be seen that between the white color, the additional nipples and wattles there is a weak repulsion, but even in the case of white color—wattles, where the repulsion is larger the data are insufficient for a definite solution of the question. If there is no interaction between these characters we must expect 19.5 ± 2:1 lambs both in the crossover and the noncrossover groups. The obtained data differ from the theoretically expected data, calculated for the absence of repulsion only, by 2.62 times its probable error.

"Crossing-Over" in Literature Citations—A Correction

In the JOURNAL OF HEREDITY for October, 1930, (Vol. 21, No. 10, P. 445) in the article "A Chromosomal Chimera in Tobacco," by Dontcho Kostoff, the wrong series of citations to the literature was given. The citations there given belonged with an earlier paper and through a blunder were repeated. Instead of the papers listed at the end of Dr. Kostoff's article the following should have appeared:

Literature Cited

1. BLAKESLEE, A. F. and J. BELLING. 1924. Chromosomal chimeras in the Jimson weed. *Science,* 60:19.

2. HOLLINGSHEAD, L. 1928. Chromosomal chimeras in *Crepis. Univ. Calif. Publ. in Agric. Sci.,* 2:343.

3. KOSTOFF, D. 1929-30. Biology of the callus (Bulgarian with English summary). *Ann. Univ. Sofia, Faculty Agronomy,* 8:297.

4. ————. 1930. Ontogeny, genetics, and cytology of *Nicotiana* hybrids. *Genetica.* (In press.)

5. ————. 1930a. Protoplasmic viscosity in plants. I-IV. *Protoplasma.* (In press.)

6. LESLEY, M. M. 1925. Chromosomal chimeras in tomato. *Amer. Naturalist,* 59: 570.

Copies of the correct references, on a separate sheet, may be obtained from the Editor.

HERITABLE CHARACTERS IN MAIZE

XXXVII—Brevis*

H. W. Li

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BREVIS MAIZE PLANTS

Figure 8

Brevis plants at vegetative maturity. The plant on the left is of the short type described in the text. The center plant in the photograph is of the less drawf type and has a tiller not unlike those of normal plants. The plant on the right has had the leaves removed to show the shortened internodes.

A SEMI-DWARF type of maize was noted in 1920 by Professor Hutchison, of Cornell University. It was found to behave as a simple Mendelian character recessive to the normal type. It has been used in genetic cultures under the name of brevis (*Bv bv*). Certain crosses between brevis and various linkage tester stocks were turned over to the writer by Dr. I. F. Phipps. Additional crosses were made for the purpose of establishing the linkage relations of the gene concerned.

Description of Brevis

In general brevis is not different from the brachytic plant.† In contrast

*Paper No. 169, Department of Plant Breeding, Cornell University, Ithaca, N. Y.

†J. H. Kempton, U. S. D. A., Bull. 925. '921.

to the general shortening of the internodes of the brachytic plant throughout the entire culm, the brevis plant has only the parts about the ear modified (Figure 8). The length of the internodes in the lower half of the section of stalk between the base and the ear is approximately normal. There is a marked shortening of the internodes above and below the ear for about equal distances. In the upper section of the plant the internodes are less markedly shortened than those immediately above and below the ear. This gives brevis a characteristic appearance. Brevis plants often show striking variation. Some plants are about one-third as tall as normal plants. This type usually has all of the internodes shortened more than the typical plants just described, and it is usually accompanied by thickened culms, broadened leaves, and, not uncommonly, a recurved tassel. In some cultures segregating for brevis the dwarf plants approach the height of the normal plants in the same culture except for the modified portion around the ears. Thickening of the culm is very rare in this type. In general, brevis plants attain about half the height of the normal plants of the same culture.

It is interesting to note that the tillers of typical brevis plants do not have the same modification as the main culm. They cannot be distinguished from the tillers of normal plants (Figure 8).

The tassels of brevis plants are not different from those of normal sister plants. Abundant pollen is shed. Brevis plants usually produce good ears, though the ears are smaller than those of the normal plants. Stamens have been found in the ear of a single brevis plant. It is not certain whether this is a non-heritable variation, or a mutation.

Due to the type of modification of brevis plants they are not identifiable until the plants are about half grown. Thus, brevis cannot be used as a seedling character.

Like many genetic factors of maize, brevis is not as viable as the normal plants of the same culture. From the back-cross data of *Pr pr Bv bv* × *pr bv* in Table I, there are only 995 brevis plants as compared to 1330 normal plants, while there is a normal segregation for *Pr* and *pr*. This is a deviation from equality of 167.5 ± 16.27. A deviation ten times its probable error would suggest that brevis is less viable when grown in the field than normal plants.

Linkage Relations of Brevis

In the F_2 generation segregating for *Pr pr* and *Bv bv* in the repulsion phase, ratios approaching 2:1:1:0 were observed in several cultures. This indicates a fairly close linkage between these two factors. Back crosses were made and the results are shown in Table I.

It is evident from these data that *pr* and *bv* are linked. The data from back crosses in the repulsion phase show 21.7 ± 0.80 per cent of recombinations. With a population of this size, the determination of the approximate distance of *bv* from *pr* is fairly reliable.

Order of the Genes

In order to determine the approximate location of *bv* in the *Pr pr* chromosome, a red aleurone virescent-3 plant was crossed with a brevis plant. A classification of 672 plants in the F_2 generation indicated a linkage between *bv* and v_3 of such an order as to give about 23 per cent of recombinations. These data considered with the results of Phipps* who found that *pr* and v_3 gave a recombination value of 26.7 per cent, suggest that the order of the genes might be *pr*—*bv*—v_3. It is recognized that the data presented are not sufficient to establish conclusively the order of the genes concerned.

*Phipps, I. F., *Cornell Agr. Exp. Sta. Mem.* 125. 1929.

Tests of Brevis with Other Linkage Groups

A summary table (Table II) is given to show the independence of brevis with the other nine linkage groups of maize. All of the data are from back crosses. The deviations from the expected equality of parental and new combination classes are not significant as compared to their probable errors with the exception of one, namely, the deviation in the back cross involving *C* and *bv*. Here the new combinations exceeded the parental combination in numbers. It is safe to conclude that *bv* is inherited independently of the genes in groups tested.

When brevis and brachitic were intercrossed, normal F_1 plants were obtained. A ratio of approximately 9 normals to 7 dwarfs was obtained in the F_2 generation.

Summary

Brevis, a recessive factor for semi-dwarf plant, was found to be linked with *pr* and v_3 of the *pr*-v_3 linkage group. The order of the genes suggested by the data is *pr*—*bv*—v_3. The recombination percentage for *bv* and *pr* was 21.7 ± 0.80. It was found that *bv* was inherited independently of *C, sh, wx, g, R, su, Tu, B, lg, Y, Pl, f,* ts_2, *ra, cr, A and* ts_4.

TABLE I.—Progeny of the back-cross $\frac{\text{pr Bv}}{\text{Pr bv}} \times \text{pr bv}$

Pedigree number	Parental combination		New combination		Total	Recombinations	
	pr Bv	Pr bv	Pr Bv	pr bv		Number	Per cent
431	87	90	30	10	217	40	18.4
432	140	114	37	26	317	63	19.8
433	82	101	20	17	220	37	16.8
434	67	72	27	16	182	43	23.6
435	15	21	13	2	51	15	29.4
436	69	39	20	5	133	25	18.8
437	28	18	11	6	63	17	27.0
438	44	37	12	6	99	18	18.2
439	58	43	22	11	134	33	24.6
440	53	35	18	5	111	23	20.7
441	39	32	23	9	103	32	31.1
442	69	45	37	12	163	49	30.1
443	70	55	18	9	152	27	17.8
444	89	77	23	25	214	48	22.4
225-5 x 2021	77	53	32	4	166	36	21.7
Subtotal	987	832	343	163			
Total	1819		506		2325	506	21.8

TABLE II.—Summary of back-cross tests of Brevis wih factors in other linkage groups

Genes involved	Phase	Number of individuals				Parental combination	New combination	D/PE
		Bv		bv				
		X*	x	X	x			
C	Coupling	52	70	66	45	97	136	3.8
sh	Repulsion	90	38	73	29	111	119	0.8
wx	Repulsion	77	51	62	40	113	117	0.4
g	Repulsion	69	68	68	58	136	127	0.8
R	Repulsion	23	21	19	30	40	53	2.0
su	Repulsion	105	72	82	53	154	158	0.3
Tu	Coupling	64	96	43	79	143	139	0.4
B	Coupling	263	238	205	225	488	443	2.2
lg	Repulsion	113	108	87	74	195	187	0.6
Y	Coupling	43	52	21	30	73	73	0.0
Pl	Coupling	66	63	44	46	112	107	0.5
f	Repulsion	54	21	49	24	70	78	1.0
ts_2	Repulsion	65	41	40	30	81	95	1.6
ra	Repulsion	67	62	54	63	116	130	1.3
cr	Repulsion	101	66	66	50	132	151	1.7
A	Repulsion	138	133	91	107	224	245	1.4
ts_4	Repulsion	23	22	24	27	46	50	0.6

Eugenics, Not "Bluegenics"

"Eugenics has been called the 'dismal science' by romantic people who chafe under the restrictions of common sense, and by conscientious individuals who are depressed by the appalling hereditary blunders made by mankind, but, as a matter of fact, eugenics presents the brightest hope for the future of humanity. Some of the unattractiveness of the eugenical program lies in the fact that it calls for results in the distant future in which there can be little or no personal participation, and often at the expense of present-day comforts. It is a lofty ideal of altruism and patriotism, which in the ringing words of Major Leonard Darwin is *'an ideal to be followed like a flag in battle without thought of personal gain.'*"—WALTER, H. E., *Genetics,* third revised edition, p. 330. Macmillan, New York, 1930.

CAN SINGLE-OVUM TWINS BE OF OPPOSITE SEXES?

MAX LEVIN, M. D.
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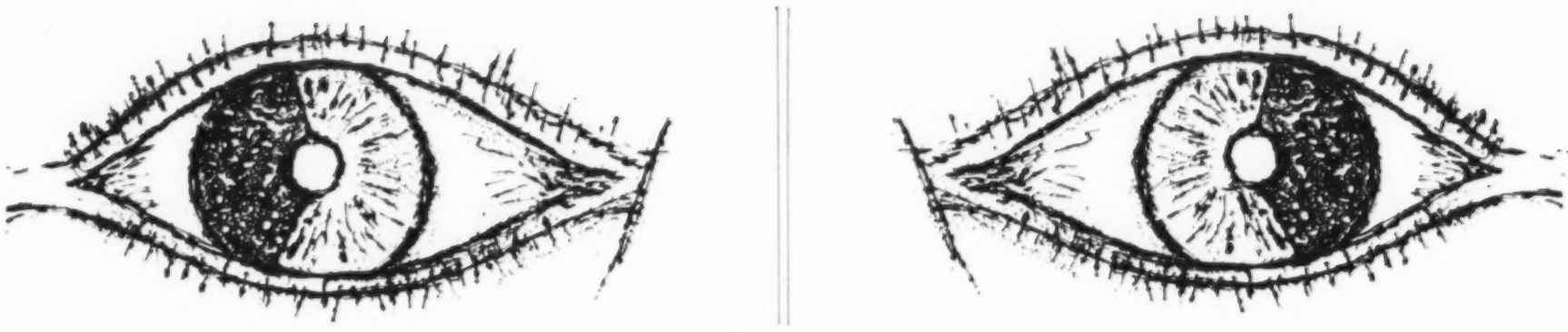
A HEALTHY, well-developed man of 37, a book salesman, called on me several months ago to sell me some books. As I looked at him I noticed that he had an anomaly of the right iris, the latter being blue everywhere with the exception of a sharply circumscribed segment of medium brown situated in its lateral half. If one were to superimpose the face of a clock on the right iris, the segment of brown would occupy the portion from seven o'clock to eleven o'clock. The brown coloration occupied this entire segment—that is, from the pupillary margin to the corneal-scleral junction. The anomaly had been present as long as the man could remember. The left iris was blue throughout.

This type of iridic anomaly is not uncommon and would have merited no further attention, were it not for the fact that my visitor stated that his twin sister, who had died some years previously, had an exactly similar segment of brown situated in the lateral portion of her *left* iris, the location being exactly symmetrical with that of the segment in my visitor's right iris. In other words, the man's right iris was a mirror-image of his sister's left iris.

The experience of recent years has shown that single-ovum twins tend to show mirror-image similarities, particularly in their ectodermal structures. Thus Newman,[2] in an extensive study of the Texas armadillo, which normally propagates quadruplets derived from a single fertilized ovum, found a tendency to mirror-image similiarity in the arrangement of the "scutes" in the bands of the armor which that animal possesses. To illustrate, one fetus had a "double scute" in a certain band, near the right margin, while the fetus with which it was paired had a similar double scute in the same band, near the *left* margin. Newman cites the work of Wilder, who in studying the palm-prints of "identical" human twins found a strong tendency to symmetry reversal: for example, the print of the left index finger of one individual mirrored that of the *right* index finger of his twin. Newman likewise refers to Sano, who found a similar mirror-image relationship in the crown whorls of two twin boys. Finally, Hirsch[1] has recently shown that in a pair of single-ovum twins the probability that one will be right-handed and the other left-handed is greater than in the case of fraternal twins and ordinary brothers and sisters. Thus, Hirsch found that among 43 pairs of single-ovum twins, 18 pairs (42 per cent) had a left-handed member, whereas among 58 pairs of fraternal twins, only seven (12 per cent) had a left-handed member.

The tendency of single-ovum twins to present mirror-image similarities is understandable in the light of their origin. Upon fission of the fertilized ovum, the two resulting cells are exact mirror-images of each other, and if at this moment they separate they will thereafter tend to maintain the same mirror-image relationship. On the other hand, in the case of fraternal twins, the probability of a mirror-image relationship with respect to any given trait is no greater than it would be for ordinary siblings for that particular trait.

Because of these considerations Newman stated, "The occurrence of



Brother Sister

LOCATION OF THE PIGMENTED SECTOR

Figure 9

Diagram illustrating the location of the brown sector in the irises of the twins,—the heavily shaded portion being brown and the rest of the iris blue. No other members of the family had anomalies of the iris, and the probability of such a mirror-image relation occurring by chance is extremely small. On the other hand, the possibility of twins of different sex being identical rather runs counter to many of our ideas of the twinning process. Viewed from any angle the case raises a number of interesting questions.

symmetry reversal or mirror-imaging in twins may safely be taken as a criterion of their monozygotic origin." This statement, while sound in principle, needs a slight qualification. The value of mirror-imaging as a criterion of monozygousness depends on the nature of trait in respect to which the mirror-imaging exists and on the improbability of accounting for the mirror-imaging by chance. For example, single-ovum twins tend to reverse each other in handedness. Left-handedness, however, is not an extreme rarity, and the chance of having one member of a pair of fraternal twins right-handed and the other left-handed is far from remote. The existence of opposite handedness, therefore, cannot in itself be taken as a safe criterion of monozygousness. On the other hand, a segment of brown occupying the portion from seven to eleven o'clock in the lateral half of a blue iris is a comparatively rare trait, and the probability of an ordinary sibling possessing exactly the same anomaly in the lateral half of the opposite iris is infinitesimal. It therefore seems justifiable in the case here recorded to apply Newman's principle and to regard the symmetry reversal of their irides as indicative of the monozygous origin of my visitor and his sister.

The question then arises, "Can single-ovum twins be of unlike sex?"

Whether under certain conditions a fertilized ovum can split in such a way that one cell contains the chromosomal pattern for maleness and the other for femaleness is a question that must be left to geneticists to answer. On the other hand, granting that a fertilized ovum has split into two cells, both of which contain the chromosomal pattern for a given sex, whether one of these cells can undergo such modification as to transform its sex is a question on which some recent experimental evidence can be brought to bear. Riddle[3] has recently called attention to the fact that in "a score of animal types . . . . complete or partial sex transformation has been repeatedly accomplished." He cited the experiment of Benoit who showed that excision of the left ovary of chicks in the first weeks after hatching transformed them into normal males. Riddle demonstrated a relationship between sex differences and metabolic differences, and, referring to the experimental sex-reversals that have been reported, he stated, "When the reversals have been made in a male-to-female direction, the procedure adopted by the experimentalist was such as would lower the rate of metabolism; and when changed in a female-to-male direction, the procedures

would lead to an increased metabolism in the treated eggs or individuals."

The possibility of experimental sex-reversal in sufficiently young animals having been demonstrated, two questions occur: (1) Can conditions arise in the uterus of such a nature as to modify the sex of a human fetus? and (2) Can conditions arise of such a nature that one member of a pair of single-ovum twins undergoes sex-reversal, the other remaining unchanged? To both of these questions the proper answer, at the present time, would appear to be, "Possibly so." Indeed, the instance of the book salesman and his twin sister lends the matter a certain probability. Conclusive experimental proof is, of course, for the time being lacking.

Since laymen are notoriously inaccurate observers in medical matters, one may wonder how much we may rely on the man's description of his sister's left iris. The condition is sufficiently unusual to make it probable that it was the occasion of frequent observation and comment at the hands of relatives and friends. The description given by the man may therefore, I think, be accepted.

Incidentally, the man's father had blue eyes, the mother grey eyes. In addition to the twins, there were nine children, each of whom had blue eyes. Aside from my visitor and his twin sister, no one in the immediate family had any iridic anomalies.

Summary

A blue-eyed man was observed with a segment of brown in the lateral half of his right iris. He reported that his twin sister, who had died some years previously, had had a similar segment of brown in the lateral half of her left iris, her left iris being a mirror-image of the man's right. Since the presence of such a unique mirror-image relationship is strongly suggestive of a single-ovum origin of the twins, it seems possible for single-ovum twins to be of opposite sexes.

Literature Cited

1. Hirsch, N. D. M. Twins: Heredity and Environment. Cambridge: Harvard University Press, 1930, p. 38.
2. Newman, H. H. The Biology of Twins (Mammals). Chicago: The University of Chicago Press, 1917.
3. Riddle, O.: Some Interrelations of Sexuality, Reproduction and Internal Secretion, *J. A. M. A.* 92: 943 (March 23) 1929.

Revamping the Personality

Denison, J. H. The Enlargement of Personality. (Behavior Patterns and Their Formation.) Pp. XXII+340. $3.00. Charles Scribner's Sons. New York. 1930.

THE human individual is an exceedingly complex integration of biodynamic factors, the elements of which in some respects do not readily lend themselves to comprehensive observation and scientific evaluation. In an attempt to shed light on the development and expansion of the so-called "personality" the author has discussed a group of these dynamisms which are better known to the modern psychologists as "identifications" or as "introjections."

During the course of growth and training the child gradually builds in a picture of himself composed of a mixture of conscious and unconscious imitations of different members of the family, of the gang of playmates, of the teachers and of the desirable "heroes." Naturally this picture, or ideal, of the self becomes modified during such important somatic and emotional experiences as the period of adolescence, as falling in love, as becoming a parent, etc. The construction of this personality pattern also depends in part upon the traditions of the race and of the family and upon the work-

ings of the taboo with its personal representations in the "conscience" of the individual. The author has described the taboo systems and their significance in an interesting manner with a wealth of examples gleaned from the behavior of primitive peoples in several lands. He has emphasized that the thoughts of civilized man are still being shaped by taboo barriers in a fundamental way, as there is plenty of evidence that patterns of the tribal variety exist in our concepts of ourselves and of our friends.

The classes of mankind determined by birth, prestige, social laws and by occupations differ considerably among themselves, each tending to create a "peculiar self with definite idiosyncrasies," and the mental picture a man has of himself exerts a powerful influence in the direction of "good" and "bad" behavior, superman and inferior adjustments, and criminal and creative activities. Notwithstanding a considerable degree of fixity in these patterns it is possible and indeed not infrequent under certain circumstances for a person to change the self or behavior pattern. In order to bring this about the individual must be dissatisfied with himself and his adjustment to society, and while in this state come under the influence of a powerful emotion such as those engendered by love, fear or supercharged religious situations. (People satisfied with themselves or possessed of the type of consciousness termed the "enlarged self" are not easily converted in any sense of the term.)

A thorough understanding of the self allows a choice, in some degree, of a standard of behavior. Denison feels that "Education could do nothing better for a man than to provide him with the finest possible concept of himself. After this is done it is worth while to enlarge the self by the usual methods of carrying out its interests into every realm of human knowledge. But to enlarge a man's powers while he still has an ignoble concept of himself seems of dubious value." He would group individuals from a functional standpoint into "receptive" and "radiative" types with a sufficient number of differentiating features and behavior subtypes to be of practical value in estimating the possibilities of transformation or enlargement of the personality, not only in its ordinary expressions but in its various disordered and conflicting forms.

The self may be temporarily or permanently enlarged by annexation, and intensification of interests, by expansion and irradiation of interests, by projection, by conflict, by emotion and by suggestion, all of which mechanisms when analyzed and their import evaluated suggest a focus in the statement. "Although it seems impossible to create new abilities in any man, it is probable that if every man used to the maximum the abilities he possesses, the world would be full of Cæsars and Napoleons." Temporary explosive expansions and modifications of the self are of common occurrence by means of the action of fear, anger, sex emotions, religious enthusiasm and exogenic intoxications.

Through fifteen chapters of well presented material the author reveals the motives of our conduct and some of the methods by which it may be modified, but there is a possibility that the general reader may gain the impression that undesirable traits in the personality are more readily modified than is actually the case. As a matter of fact, there is a concordance of opinion among those engaged in active psychotherapy that personality or character traits in adults are very rigid and difficult to modify by any method of approach. The time to make the impression is during the early childhood years of training, when the individual is capable of changing his patterns of thought. Although a little too optimistic in some respects, Denison's book should prove to be of definite educational value in the present generation.

N. D. C. Lewis.

A NEW POD COLOR IN SNAP BEANS*

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POD-COLOR IN SNAP BEANS
Figure 10

At the right is shown the green-podded type, which carries two dominant factors for pod color (*YYSS* or *YySs*). The absence of one of these factors (*yySS*) produces yellow pod color, and the absence of the other (*YYss*) produces silver. The absence of both factors (*yyss*) produces the white pod color.

THE production of new plant forms by synthetic hybridization and selection has become a very important branch of agricultural research. A cross recently made between two varieties of common beans (*Phaseolus vulgaris*) illustrates to some extent the possibilities of this line of experimentation.

The variety of field beans known as Crystal White Wax bears pods of an unusual light green color. This light green color differs from the normal green pod color by a single genetic factor and is called silver in the following discussion. When crossed with a yellow (wax) podded plant there is a new and different pod color segregated in F_2. This is a distinctly white color. The type combines the genetic

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factors for the yellow pod color with those of the light green, and does not appear unless the plant is homozygous for both of these factors. The symbols used to designate these two factors are *yy* for yellow and *ss* for the silver color. Obviously the silver podded variety carries the dominant allelomorph of *y* and the yellow type carries the dominant allelomorph of *s*. On this basis the cross may be diagrammed as follows:

Parents	*YYss* (Silver) × *yySS* (yellow)
F_1	*YySs* (normal green)

With no linkage present the following F_2 phenotypes would be expected:

9	*YS*	Green	3	*Ys*	Silver
3	*yS*	Yellow	1	*ys*	White

The actual figures obtained agree very well with this hypothesis They are given below for the F_2.*

The *P* value for these figures is .04. These are the combined data from crosses between the varieties Crystal White wax and Refugee wax and the former by Wardwell's wax. The F_1 was made up of nine green podded plants.

Further support of the theory was obtained by making a breeding test of the different F_2 classes. Progenies were grown from 30 of the green podded F_2 plants. Comparison of the expected and actual numbers of the four genotypes is given below.†

The *P* value is .74 showing good agreement between the observed and expected.

The thirteen green podded F_2 plants that proved to be heterozygous for both factors were expected to give a 9:3:3:1 ratio in F_3. Comparison of observed and calculated numbers follows. The *P* value for these data is .64.‡

The five green podded F_2 plants that were heterozygous for the *y* factor produced F_3 pod colors in agreement with the theoretical results of three green to one yellow:

	Green	Yellow
Observed	117	43
Calculated	120	40

$D=3\pm3.69$

The nine green podded F_2 plants that were heterozygous for the *s* factor also gave F_3 results in good agreement with the expected ratio:

	Green	Silver
Observed	275	86
Calculated	271	90

$D=4\pm5.55$

The yellow and silver podded F_2 plants also gave F_3 results in agreement with the hypothesis. Ten of each of these colors produced progenies in F_3. Of the yellow, 7 produced yellow and white, in the proportion of 137 yellow to 44 white. The theory calls for 136 and 45, respectively. *D* equals 1 ± 3.93. Two of the progenies were entirely yellow and one was made up of 10 green and 4 yellow podded individuals. Undoubtedly this F_2 plant was green podded and was wrongly classified. Omitting this line from the calculations the other 9 were from 7

	Green	Yellow	Silver	White
*Actual	265	67	60	26
Theoretical 9:3:3:1	234	78	78	26
Difference	31	—9	—16	0

---

†Expected ratio	Factors	Calculated number	Observed number	Difference
True breeding	*YYSS*	3.3	3	0.3
3 green : 1 silver	*YYSs*	6.7	9	—2.3
3 green : 1 yellow	*YySS*	6.7	5	1.7
9:3:3:1	*YySs*	13.3	13	0.3

	Green	Yellow	Silver	White
‡Observed	288	94	82	30
Calculated	278	93	93	31
Difference	11	1	—11	—1 .

plants heterozygous for *s* and 2 homozygous. The expected numbers being 6 and 3 respectively make the deviation equal to 1 ± 0.95. Of the 10 silver podded F_2 plants tested, 6 gave both silver and white and in the ratio of 107 silver to 44 white. The expected numbers are 113 and 38. The deviation, therefore, is 6 ± 3.59. The deviation between theoretical and actual genotypic ratios is 0.33 ± 1.00.

Six progenies were grown from white podded F_2 plants giving 136 F_3 individuals all of which bore only white pods. Selections of these have now been grown to the fifth generation and no segregation for pod color has been noted.

Believing that this white color might be a desirable characteristic for a commercial variety of snap beans, since it gives the beans a delicate and attractive appearance, an attempt is being made to combine it with other characters desired in a variety of snap beans. The genetics of the color character being comparatively simple makes success for this attempt seem probable.

A Guide for Poultry Specialists

POULTRY HUSBANDRY, by M. A. Jull. Thirty-three chapters, 639 pp., 229 text figures, Price $4.00. The McGraw Hill Book Co. New York.

IN this volume, Dr. M. A. Jull, Senior Poultry Husbandman, Bureau of Animal Industry, United States Department of Agriculture, has compiled considerably more than enough useful information to justify the publishers' claim that it is a "veritable encyclopedia of poultry husbandry." In this age of specialization it is so difficult for any one man to keep abreast of the whole line of march, and it is so easy to concentrate on our own special interests, that many poultry husbandmen are really specialists in nutrition, in genetics, in pathology, in embryology or in economics. All of these and their students will thank Dr. Jull for having presented within the covers of one book information about every branch of the poultry industry which could possibly be included in the term poultry husbandry.

After discussing the uses of poultry products, the author gives a survey of the poultry industry in the United States of America, and some information about the various breeds. Then follow brief chapters on the anatomy of the fowl, on egg formation and on judging poultry for exhibition and for production. In four chapters devoted to breeding the reader is given in turn some of the principles of genetics with examples of characters inherited in various ways, a review of genetic investigations of the inheritance of egg production, breeding practice and an excellent account of the breeding records used at the U. S. Department of Agriculture. A short review of embryo development and metabolism precedes very comprehensive chapters on the principles and practices of incubation which present a better review of modern investigations in this field than is obtainable in any other single publication. Newer developments in brooding and rearing chicks, broiler production, caponizing and poultry house equipment are all treated in turn.

In over one hundred pages devoted to nutrition and feeding are many quotations from researches in this field and references to others. The findings cited are often at variance but the author evidently feels that it is better for the reader to digest the papers cited and to draw his own conclusions than to have it done for him. Modern methods of control of some of the worst fowl diseases and parasites of the United States are presented largely in the form

of liberal excerpts from the writings of various veterinarians. In the last six chapters the business side of the poultry industry is considered under the following heads: marketing eggs, marketing chickens, by-products of the chicken industry, the economics of production and marketing, records and accounts and poultry plant layouts.

One of the valuable features of the book is an extensive bibliography. In many cases references in the text to the publication listed in the bibliography consist merely of lists of authors writing upon certain subjects, *ex cathedra* statements of some writers, or of such very brief mention of the subject matter that the reader is left to discover for himself which papers contain valuable data or original work and which do not. In a book of such wide scope it is probably impossible to do otherwise, but the reader familiar with the literature will sometimes wish that Dr. Jull had not contented himself with quotations from authors' summaries, or with abstracts from the *Experiment Station Record*, but had been somewhat more critical of the sources of data and the interpretations placed upon them. For example, one would like to believe that a flock of fowls could be made to produce only large eggs by as simple a process as that of making the birds homozygous for gene *B*, but it is doubtful if many geneticists could be convinced of such a possibility by any evidence which has been offered to date.

On page 246 is a table showing the feed required to produce gains in weight at different ages, cited, with modifications, from a popular poultry magazine. Examination of the orginal source reveals that the magazine writer has in turn, quoted the figures upon the authority of some unnamed person of whose investigations and qualifications we are told nothing except that he could make predictions about the best time to market broilers. If such figures are to be included in the book at all it would, perhaps, have been better to designate them as estimates rather than as "data."

Readers will also wish, in several cases where findings of various investigators are cited in rapid succession, not always in accord or even in the same terminology, that Dr. Jull had expressed in his own words the actual addition to knowledge made by the combined results of the various researches cited.

Minor errors of various kinds are few in the text but are quite numerous in the bibliography. In the latter section it would seem preferable, as far as available type permitted, to follow the usual custom of citing titles of publications in the languages in which they were originally printed. It is regrettable that such an authoritative work should follow (p. 138) the too-common poultryman's custom of using that recently coined etymological atrocity "livability" in place of the word *viability* which the language provides for the meaning intended.

Lack of space prevents giving details of the really great amount of information which has been compiled and presented in graphic or tabular form. Suffice it to say that Jull's *Poultry Husbandry* will undoubtedly prove an invaluable reference book and a guide to the literature for students, teachers and investigators in all phases of the poultry industry.

F. B. Hutt.

INEQUALITY OF COTTON FIBERS

A Direct Method of Comparing Substaple

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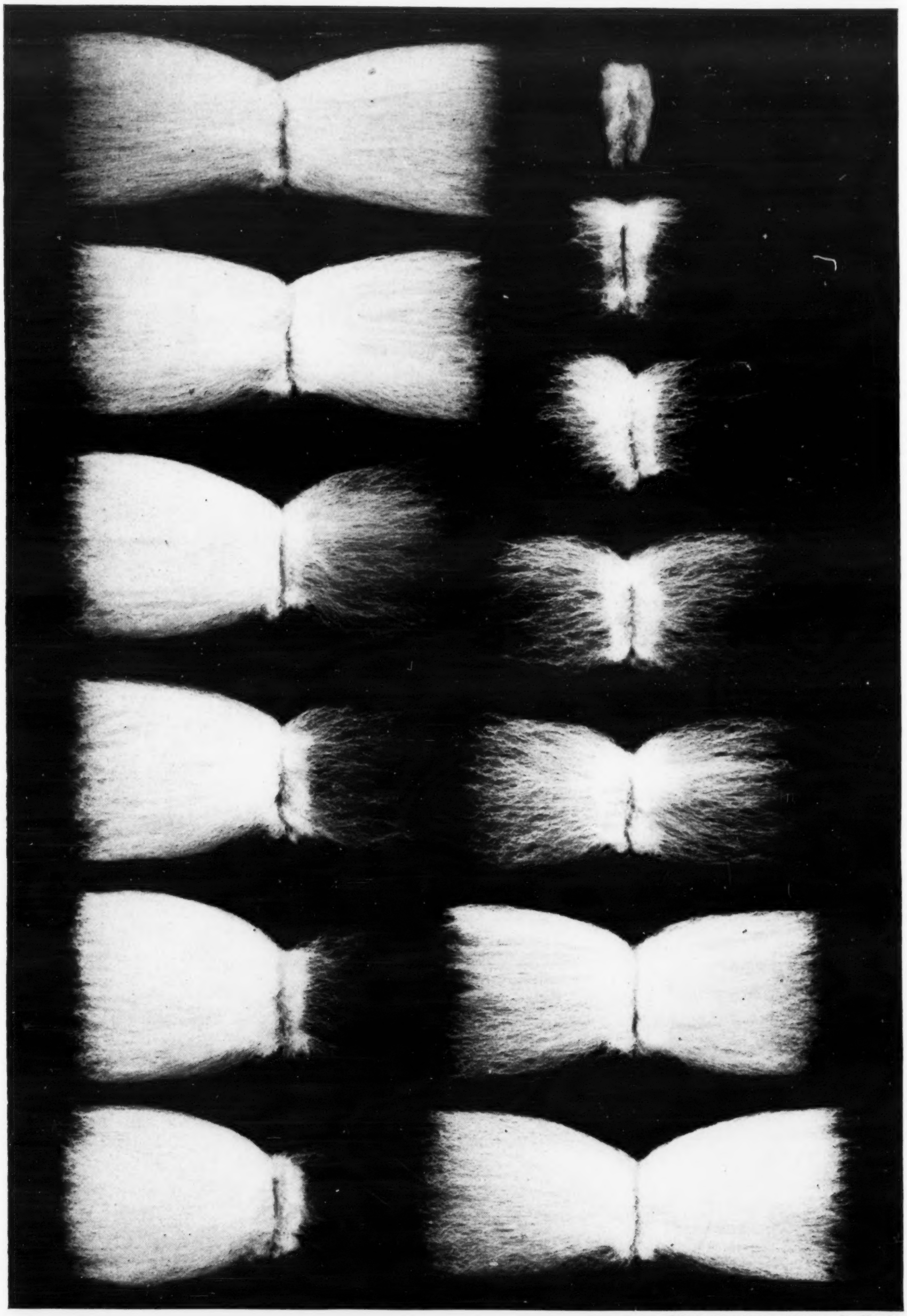
COTTON fibers are not of equal length, even on the same plant or on an individual seed. The fibers are formed as specialized large cells that grow from the surface of the seed, but many do not reach the full length. From the nature of the fibers, it would not be supposed that all of the free-growing cells would attain the same development. Short fibers are always to be found among the longer fibers, as can be seen by combing the fibers straight while still attached to the seed. With the lint straightened by combing, it is possible to pull out the longer fibers without disturbing the others, and this can be repeated with successively shorter fibers. Thus the proportion of fibers above or below an inch can be determined readily, or separations of different fiber lengths may be made to any extent that seems desirable. The separation of successive lengths of fibers is shown in Figures 11 and 12.

Machines have been invented to facilitate the analysis of commercial samples of cotton by sorting the fibers into different lengths so that the proportions of each length of fiber can be determined. These methods are valuable in affording comparative analyses of the inequality in commercial samples, but for the purposes of the plant breeder, the method of combing the fiber on the seed is more simple and direct, and is capable of giving more definite and reliable results than the mechanical methods applied to ginned fiber. As the figures show, it is possible to make the separations of fiber lengths with care and accuracy, and the results can be checked and substantiated by permanent photographic records. Since the arrays of fiber lengths are made with material of known origin and not from composite samples as in the mechanical method, the causes of inequalities may be determined and in some cases may be immediately evident.

The shorter fibers of a cotton seed have been called substaple, and the term may be useful as a means of distinguishing the shorter fibers which are normally present from other kinds of inequalities which usually are represented in commercial samples. Mixtures of short staples in commercial samples should not be confused with substaple differences between different varieties or between growths of the same variety under different conditions. Standards of staple-length, to be of constructive value, need to be established on a basis of actual production from good varieties, not from miscellaneous commercial samples of unknown character in regard to variety or conditions of proproduction.

The improvements in uniformity of fiber that can be made by breeding are not understood or appreciated unless the underlying inequality of the fibers is recognized. Cotton may be considered "uniform" if all of the short fibers come from the substaple. Adding more short fibers, as by careless breeding, mixing with inferior varieties, or growing the crop under poor conditions, can be avoided, but entire freedom from substaple is not to be expected. The textile engineer who is looking for cotton with all of the fibers of equal length is sure to be disappointed.

The general occurrence of the shorter fibers, even in long staple cottons, is familiar, of course, to every cotton breeder, from the very first stage of his experience, and this may be the principal reason why the existence of

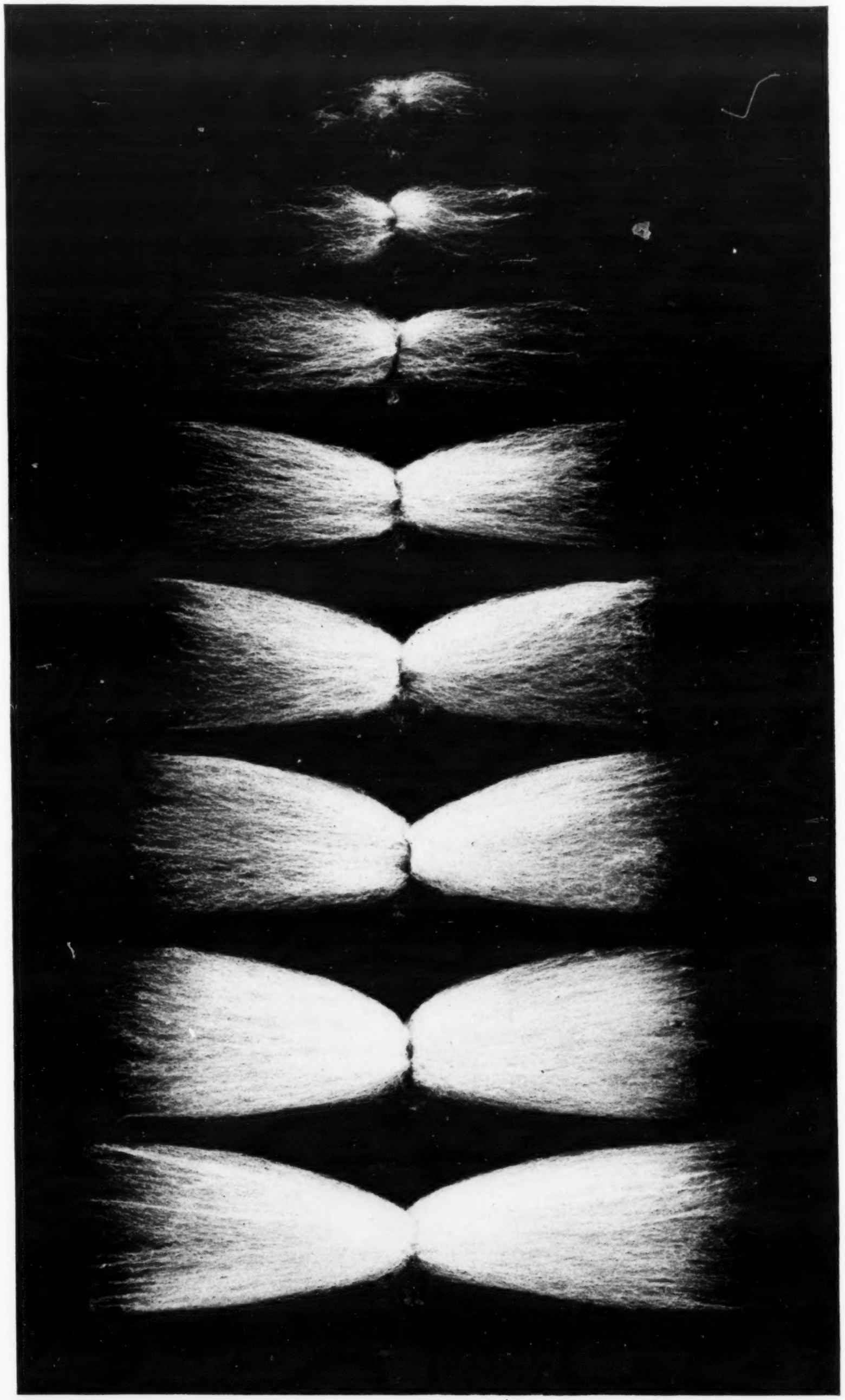


Photographs by Robert L. Taylor

"SUBSTAPLE" NORMAL IN COTTON

Figure 11

Combed fiber on seeds of Acala cotton grown at Shafter, California, in 1929, with successive removals of the longer fibers from one or both sides, showing residual shorter fibers of different lengths. (Natural size.)



"SUBSTAPLE" OF SEA-ISLAND COTTON

Figure 12

Substaple of Sea Island cotton, showing a more gradual succession from longer to shorter fibers than in upland cotton. (Natural size.)

substaple has remained so little recognized by commercial cotton experts and technologists. All varieties have substaple, even those that lack the still shorter fuzz fibers that cover the surfaces of the seed. For people who have never seen cotton in the field the substaple and the short fuzz that covers the seed-coats may appear as something abnormal. Fuzz of a grayish color has even been mistaken for mildew. The breeders did not call special attention to the substaple and the others did not observe it, except as they knew that cotton might be "mixed" or "irregular" and that some samples were worse than others. Having no contacts with the plants in the field, and no occasion to examine the "seed cotton" before ginning, the buyers and commercial "classers" have no direct means of informing themselves regarding the natural inequality of the fibers. On account of the substaple, the charge of irregularity can be made against any sample of cotton, and can always be substantiated, at least to the extent that short fibers can be found and exhibited to the farmer and the by-standers, by any buyer who knows how "to pull the staple."

Expedients in Buying Cotton

Depreciation of the farmer's cotton is a recognized art among buyers, and is practiced especially with the better staples, on which premiums are paid. Any reason or argument may be advanced that can help the farmer to part with his cotton for less than he expected to receive. "The market for such cotton is going off," "the cotton is not of the 'character' that is now in demand," "no premiums are being paid this season." Or it may be objected that the fiber is "too rough" or "too smooth," "too hard" or "too soft," "too short" or "too long," or "too irregular." The grade may be "too low," the cotton may be "tinged," or the fiber may be "gin-cut." These and many other objections have been heard in cotton markets, and commonly are justified by the facts, but often are fictitious. The farmer usually knows nothing of the essential quality of his cotton, and the buyer often knows as little as the farmer. The arguments go on from year to year with local variations but essentially the same. In the words of a respected cotton merchant in a Southwestern city: "There has to be something the matter with the cotton."

A double advantage may be gained if a report can be floated that will frighten a buyer's competitors, as well as induce the farmers to sell at lower prices. Scares may be started by discovering the substaple anew, or in many other ways. "Lack of spirality," that is, of spiral twist of the fibers, was alleged as a commercial objection to the select type of Egyptian cotton raised in Arizona, although later it was found that this cotton exceeded the imported Egyptian fiber in the particular textile qualities that spirality is supposed to furnish. A buying campaign on "soft" cotton was pushed in one district to the extent that half of the crop was being penalized, although some of the buyers admitted to the County Agent that they had no facts to show that the cotton was weak or inferior. When spinning tests finally were made, the strength of the fiber was found to be normal.

Enough usually is the matter with cotton to warrant one stricture or another, since very little of the crop is as good as it might be, and much is far worse than it need be, if only a little care were taken. Buyers of good fiber may object very properly to having the cotton in poor condition or badly ginned, or to the bales being loaded at the gins with linters and short fiber which could be avoided if the farmers did not demand high "turnouts." The ginners comply, though close ginning is known to be detrimental, in adding more waste and "neps" to the cotton. A few of the more competent buyers understand that the high-turnout bales are to be avoided, though open objections on this

score are not heard. Where cotton is bought at the gin the character and condition of the fiber could be observed before ginning, but usually no such attention is given.

The buyer's criticism would be constructive if based on facts, but good cotton may be libeled as freely as bad cotton is condemned. The patter of the irresponsible buyers undoubtedly is an important factor in keeping the varieties mixed, and the crop inferior. The idea of "changing the seed" has developed with many farmers almost to an obsession. Even in districts where seed-stocks of good varieties are being preserved by selection, a hue and cry for "changing the seed" may be started at any time, to the detriment of every interest of the community in improved production. A general work of education needs to be done among cotton-growers to extend the practice of selection and escape such notions as "changing the seed" and demanding high turnouts at the gins, which directly interfere with improvement of production.

A Special Marketing Problem

Experience of many years with efforts of improvement leaves no doubt that the production of superior cotton carries with it a special marketing problem. Good cotton will not be grown regularly and in adequate quantities by farmers who are entirely at the mercy of the buyers. The farmers of a producing community must know the value of their cotton and find the way to sell it at a fair price. They should not be unduly discouraged by any information received from commercial sources, but must try to substantiate facts. The buyer naturally is ready to express any misgivings he may have about the cotton, or to make full use of any question or objection that may be heard in any quarter. The skillful buyers pick out the good cotton, but naturally are not inclined to pay more than necessary. They feel no obligation to compliment the growers of the good cotton or to tell them that their cotton is worth more than is being offered for it. Good prices may be paid if buyers are competing in local markets, but even in such cases the good and poor cotton may be taken at the same price, so that no encouragement is given to the farmers who are trying to improve their crop.

The farmer must have a practical inducement from the buyer, not merely an exhortation to grow better cotton. The buyer may think it good business to make the farmer believe that even his good cotton is bad, in order to buy it more cheaply, but such transactions obviously do not contribute to the improvement of the crop, and react to the buyer's disadvantage, by causing the farmer to change to a poorer cotton. Premium varieties are available which are as productive and as early as the short staple varieties, but special precautions are necessary to maintain the stocks of pure seed, and farmers are not inclined to grow the good cotton unless they have a prospect of selling it at a better price. Nobody likes to feel that he is being "stung," or to place himself in a position of inviting that treatment. The idea that farmers should be willing to raise long staples or premium cottons and sell them at the same price as ordinary short staples, should be abandoned, since its futility is plain. The buyers must find ways of dealing constructively with farmers who produce good cotton, or some other system must be developed. Probably it is out of the question for scattered individual farmers to be assured of fair prices for a few bales of good cotton, but the market problems can be simplified greatly in communities where only one kind of cotton is grown, and commercial quantities of uniform fiber are produced. Organized communities have much to gain, if their efforts can be sustained for a period of years, and a regular production of superior fiber established.

Causes of Irregular Fiber-Length

In the absence of direct information

regarding the causes of uneven fiber, different theories are advanced. The short fibers are often ascribed to cutting of longer fibers by the gins, to poor seed, to mixing of varieties or to dry weather. Most of these theories are based on the assumption that all of the fibers would be of the same length if the cotton had not been damaged or mishandled.

Apart from the substaple, the irregularities of commercial samples are due to several causes, some of which can be avoided more readily than others. Mixing and mongrelizing of varieties undoubtedly is the principal cause of large proportions of short fibers in commercial samples of long staples or premium cottons. Unless the seed-stocks are specially guarded from admixture, large numbers of ordinary short-staple plants can be found in fields of long-staple or "premium" cottons. Indeed, this is the usual condition outside of districts where one kind of cotton is grown exclusively, and the seed kept pure. Mixing of seed of different varieties at the public gins is a general agency of deterioration in the quality of the fiber. The worst damage is done by mixtures with varieties that have very short staples, as "Half-and-Half."

Shortening of the fiber by stress conditions is an important factor in some districts, notably in the irrigated valleys of the Southwestern States. The stress-damaged cotton could be kept separate from the good cotton if the need of doing so were appreciated, but it should not be expected that inequalities of the fiber can be completely eliminated. The substaple differences, though they may be reduced by careful breeding, may not be removable altogether. No doubt it always will be possible to say of even the best cotton, that the fiber is "irregular."

More careful study of the substaple and of the other factors of inequality undoubtedly are needed as a basis of judgment regarding the precautions that must be taken before any general improvement of the crop can be expected. Mechanical fiber-analysis of commercial samples does not distinguish between the substaple and the mixtures with short varieties that are of frequent occurrence, but the method of combing the cotton on the seed provides for comparisons of the different lengths of fiber produced by different varieties, or by the same variety as represented by different progenies, strains or seed-stocks, or as raised under different conditions. The operations that are necessary for making the fiber-length comparisons most readily and accurately need first to be considered. The labor of making such comparisons by the combing method is only a small fraction of what is required by the mechanical method. The analysis of commercial samples is important as showing the need of more attention being given to fiber inequality, but does not show how the inequalities are to be reduced. It need not be taken for granted that the methods and appliances that have been devised for analyzing commercial samples must be exclusively relied upon, especially if more definite information can be obtained by more simple methods and with less apparatus.

Comparisons of the substaple can be made by a slight extension of the usual method of combing out the fiber on the seeds, with which breeders are familiar. A sorting of the fibers of different lengths is made possible by the simple expedient of pulling out the longer fibers first, to form as many length-classes as may be desired. The gradual "milking down" of the fibers to a certain length can be done with any degree of care, and allows the separation of lengths to be made probably with greater accuracy than in any other way. The combing method has the advantage of dealing with the fibers in more definite positions than they can be placed by the mechanical sorters. The combed fibers lie parallel and in a

regular relation to each other, since they remain attached at one end.

It is true that the fibers are not attached along a straight line, or even on a flat surface, but this element of inequality, amounting to half of the diameter of the seed, apparently is much less than the slippage which occurs in machine sorting. Though the fibers are laid parallel and arranged in the general order of length, yet they are not placed very definitely in line, and many are slipped for as much as an eighth of an inch. If the slippage can be disregarded as a constant error which does not vitiate the comparisons, the same reasoning may be applied with even greater propriety to the curvature of the seed. The extent of accuracy can be determined at any stage of the operation by comparing the actual combings at the different stages of separating the fiber classes. The combings do not present all of the long fibers, as some are pulled out, but those removed in this way can be kept and weighed for quantity determinations. Adhering or tangled fibers from other seeds need to be removed before combing begins, as recognized by Allard.* Roughly the proportions of the different lengths of fibers can be seen directly in the combings or in photographs like those of Figures 11 and 12. It is plain from the photographs that very long cottons, of the Sea Island and Egyptian types, have only a few short fibers, but have a more gradual succession of the length classes than the upland cottons.

Parting the Fibers on the Seed-Seam

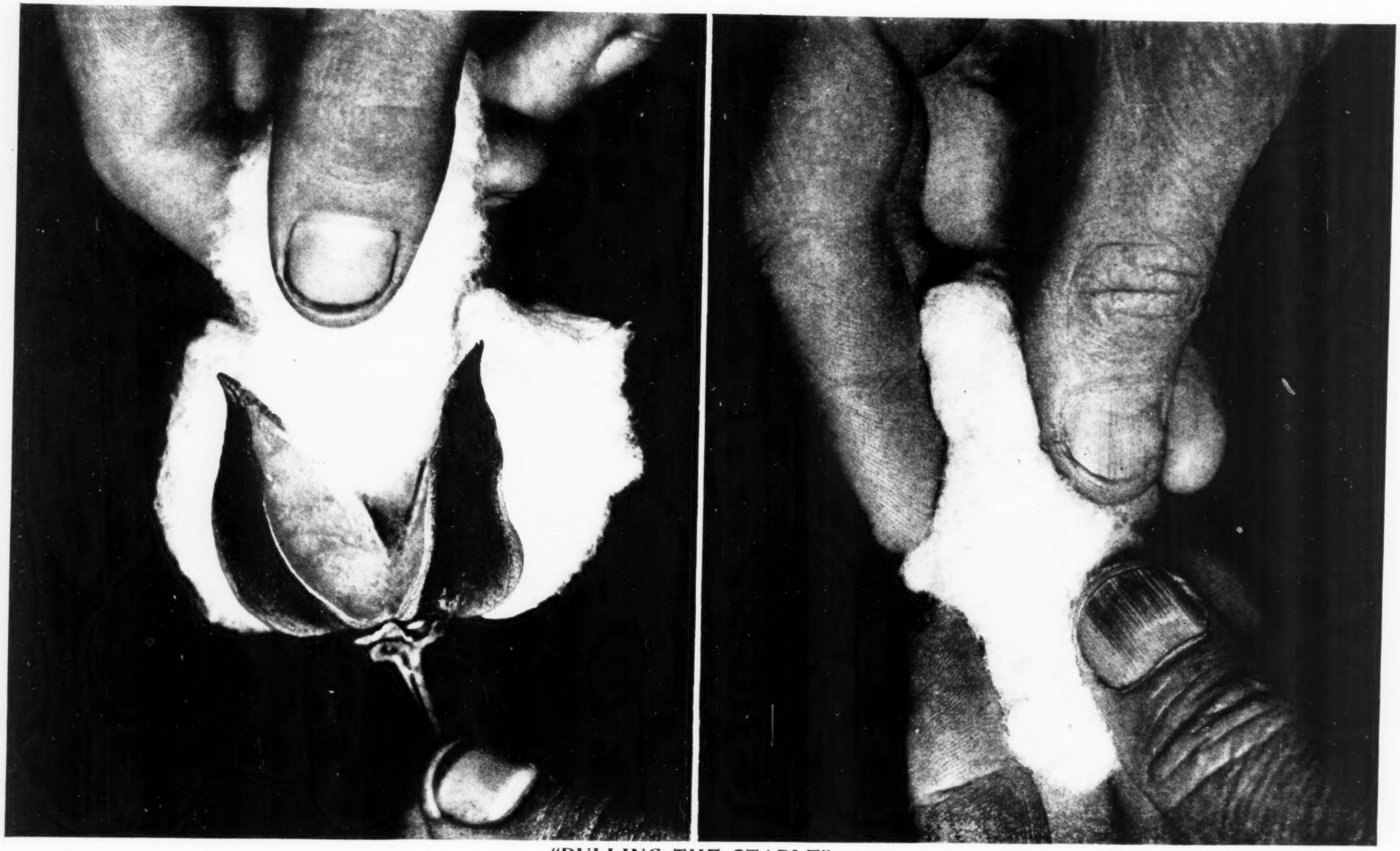
The accuracy and satisfaction of direct determinations of the substaple no doubt will depend to some extent on the skill that may be developed in combing out the fiber, as well as upon the care that is given in the separation of the different lengths. Parting the fibers regularly on the two sides of the seed is a necessary preliminary to accurate work, since the length relations might be confused if fibers were carried across the seeds instead of being parted down the middle. There is a natural seam, or raphe, on one side of the seed which forms a natural parting-place of the fiber and permits a regular orientation of the seeds in the combing operation.

The appearance of the combed specimens of fiber is much better if a good "part" is obtained, and comparisons of length and uniformity of the fiber are greatly facilitated by having the seeds in the same position and making an equal division of the fiber. Though the parting of the fibers is a simple operation, it is not easy to describe in terms that are readily understood by those who are not familiar already with the "tricks" of the cotton breeders' trade.

Learning how to locate this parting-place, may be considered as the first step in the technique of cotton-combing and of fiber-analysis by the direct method. To get the position of the raphe it is necessary to understand how the seeds are placed in the "locks," that is in the separate divisions or compartments of the boll of cotton. With rare exceptions, the bolls of upland cotton have four or five locks, while those of Egyptian and Sea Island cotton have three or four locks. In all kinds of cotton the seeds in each lock are in two rows, and are so arranged in the rows that the raphe sides of the seeds face each other.

To begin the separation of a seed for combing, the inner side of the lock, which often shows the attachments of the two rows of seeds as dark points in the cotton, should be placed upward, as in Figure 13. This position of the lock allows the raphe to be seen more readily as the seeds are drawn apart. The lock is opened gradually by pulling

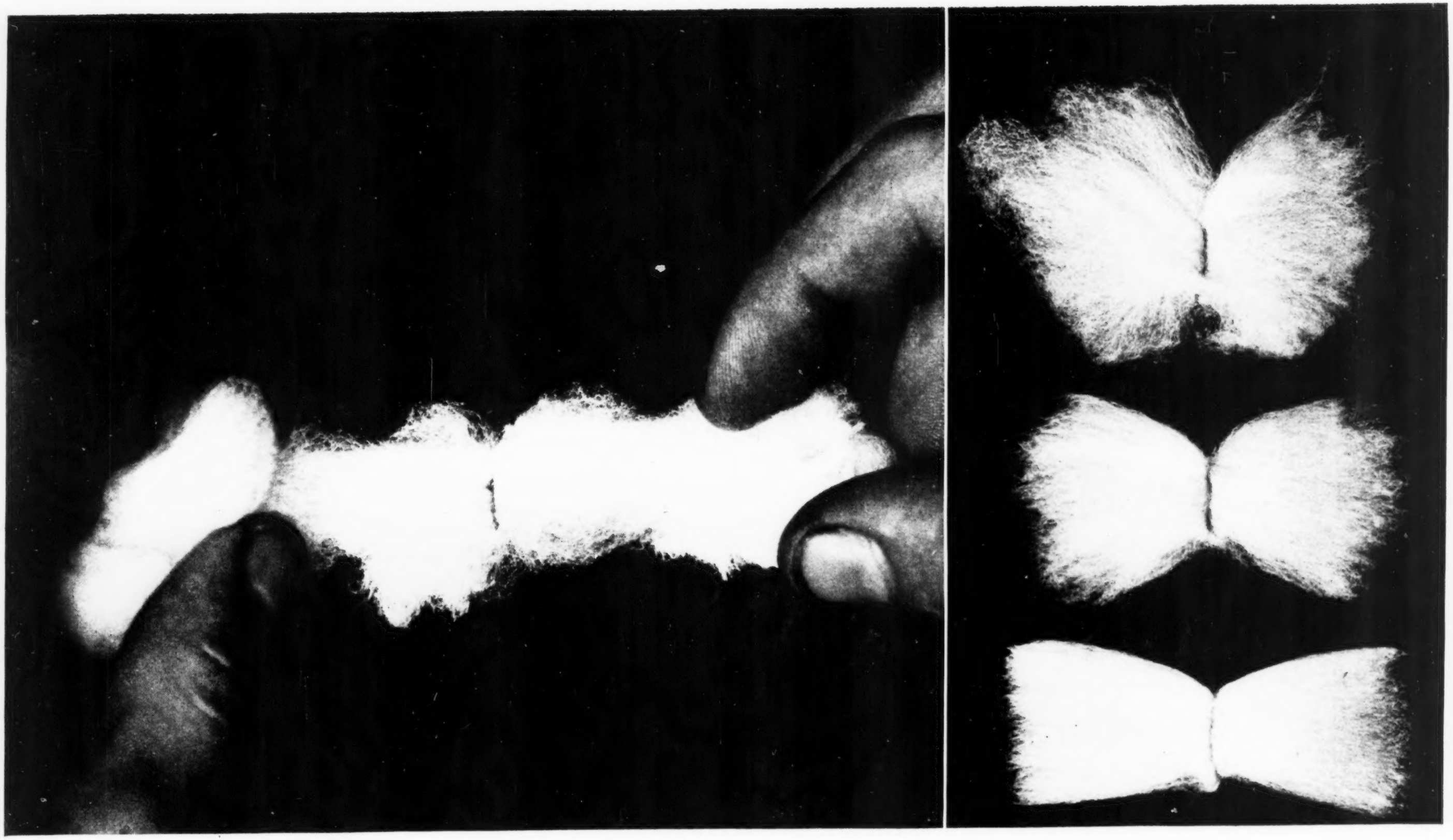
*Allard, The Fibers of Long-Staple Upland Cotton. *Bur. Plant Industry Bull.* 111, page 11, 1907.



"PULLING THE STAPLE"

Figure 13

Left—The lock is being pulled from the boll. *Right*—The lock is turned over, with the inner face upward, in the position to look for the parting of the fiber on the seeds when the lock is pulled from the ends.



SEPARATING A SEED AND COMBING

Figure 14

Left—The lock pulled apart with the fiber of one of the seeds opened along the raphe. *Right*—A seed separated from the lock, another seed with the loose fibers removed and a third with the fibers combed.

from the ends, and the seeds on the opposite side of the lock, facing the observer, are watched for the separation of the fiber along the raphe. One or more of these seeds is likely to show a good exposure of the raphe, affording a clean "part." As soon as a well-parted seed is noticed, it is grasped by the thumb and finger of the left hand, with the thumb over the "part." The right hand then is free to make a careful separation of the fibers from those of the neighboring seeds, and draw the fibers parallel. After the seeds are thus separated, as at the top of Figure 14 they are ready for the combing operation to straighten the fibers.

By the above procedure, the part is made with the seed upside down, that is with the point of attachment upward, and the seed is reversed to bring the point downward for combing. Another procedure that may be equally good is to spread the two rows of seeds wide apart with a rolling of the lock toward the operator. The effect is that the seeds are reversed before being separated, as shown in Figure 14.

The seeds at the middle of the lock seem to part much better than the others. Three or four of the well-parted seeds may be found in the same lock, if the lock is turned so that both rows of seeds may be examined, but often only one seed, or none at all, may be obtained in a satisfactory condition for being combed. Hence the beginner should allow ample material for practice work, as well as for the combings that he wishes to make.

Parting the opposite side of the seed, and then straightening the fiber at the sides complete the usual combing operation, and the regularity of the product made from the same material will show whether good work is being done. The same test of doing regular work would apply in the comparisons of substaple which can then be made from the combings by "milking out" the longer fibers and leaving the shorter attached, as in Figures 11 and 12.* For purposes of analysis, the fiber pulled to represent the different length classes may be kept separate for weighing. The operation would need to be repeated on numerous seeds, and from many separate samples, to give a basis for determining the accuracy that might be expected from such a method of analysis.

The combing needs to be done carefully and with a smooth comb. The outer ends of the fibers are straightened first, in order to have as little tension as possible and avoid breakage. A few fibers are broken, even with the greatest care, but the number of broken fibers apparently is very small, as may be seen by examining the free ends of the shorter fibers with a lens. The absence of short fibers among the long fibers as they are pulled from the seed has also been observed, which is a further indication that breakage is infrequent in the combing of normal fiber.

*The combings and photographs were made by Mr. Robert L. Taylor, of the Bureau of Plant Industry.

A WING MUTATION IN A BORBORID FLY

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THE present account is written with the double intention of recording the breeding and culture methods of a fly (*Leptocera fontinalis,* Fullen),* not used hitherto in experiments in genetics and of giving a preliminary description of a wing mutation which has appeared.

The first part of the paper is complete enough to facilitate the work of anyone who may be interested in using this fly as an experimental animal, either in genetics or in physiological work. The second part, however, is not regarded as being in any measure complete and it is offered here principally to demonstrate that efforts to use this animal in genetics are already being rewarded by promising results.

Life History and Habits

The adult insect is a rather typical Muscid fly about 2.5 mm. in length, with a grayish-brown body and blue-black irridescent wings. The eyes are dark red. It occurs very commonly upon the beach refuse on the shores of lakes, especially where such refuse consists mainly of decaying fleshy aquatic plants. Males and females are easily distingushed by the relative fullness of the abdomen, and peculiarities of the external genitalia. When the adult fly emerges from the puparium it is light in color and the wings are not spread. It is quite active, however, and the wings are soon inflated and conditioned by the tarsal brushes upon the hind legs. They are positively phototropic for some time after eclosion but the readiness with which they will respond to strong light is dulled somewhat during the latter events of adult life. The adults do not acquire their full dark coloration until about two hours after eclosion.

Copulation takes place within two days after eclosion and the female may copulate with various males during the next week or ten days, the contacts with the male being interspersed with periods of egg laying. Under natural conditions the female deposits her eggs in fairly orderly masses containing from 15 to 24 eggs and the process continues for about one week during which time a total of from 180 to 200 eggs are deposited. Under laboratory conditions especially in crowded cultures where females are continually disturbed, the eggs are laid singly and are widely scattered. The eggs are light cream colored, about three times as long as broad and are .6 of a mm. in length.

After two days at ordinary room temperature, the eggs hatch. The larvae are vigorous eyeless maggots which feed and grow for about eight days. They have a tendency to be negatively geotropic during their larval life but the tendency becomes much stronger during the last two days with the result that they find their way into drier materials. Here they form a dark, mahogany colored puparium, within which they transform for about six days. At the end of this time the adult emerges to start anew another life cycle. The entire length of the life cycle is from 18 to 25 days.

Culture Methods

The natural food of both adult and larva consists of decaying aquatic vegetation at the margin of lakes in which there is present a considerable amount of animal remains. The actual materials cannot be handled well in the laboratory but several fairly successful substitutes have been synthesized so that about eighty per cent of an entire brood can be brought to the adult stage.

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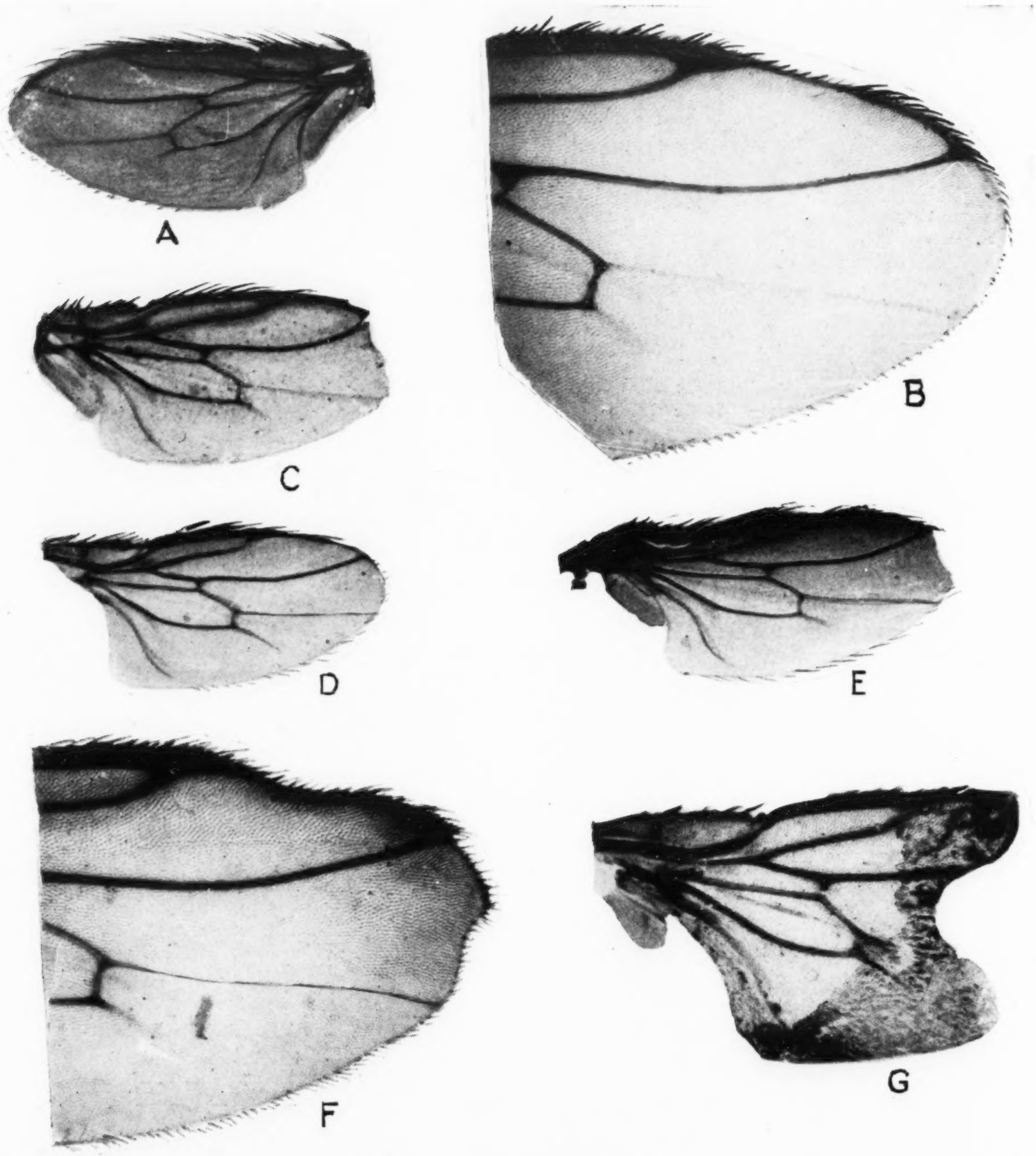
*Dr. J. M. Aldrich of the U. S. National Museum identified the fly described and his kindness is gratefully acknowledged.



SCALLOPED AND NOTCHED WINGS

Figure 15

A—Photograph of the normal wing. *B*—Distal half of a wing bearing a slight marginal scallop of the costal vein. *C*—Wing bearing a terminal notch. No scallops appear in either the anterior or posterior margins. This is the most common type of variation. *D*—Wing having a deep scallop in the costal vein but no terminal notch. *E*—Wing with tip missing. *F*—Wing in which the costal vein is both scalloped and indented. A small terminal notch also appears. *G*—Wing bearing the extreme condition of notching.

Head lettuce was boiled so as to hasten its disintegration and after being drained was placed in two quart jars together with a small amount of frog muscle. Adults fed upon these materials readily and the females deposited their eggs upon the drier portions. As soon as the larvae had hatched they began to work upon the food mass with the result that it was liquified. In order to prevent the larvae from being drowned it was necessary to

line the jars with filter paper sufficient to absorb the surplus fluid. The larvae when full grown migrated upward into the filter paper and pupated. It was found necessary to remove the adults to freshly prepared culture jars as soon as the first eggs had been laid because the movements of the larvae from the first cluster of eggs disturbed any new egg masses and made conditions unfit for them. From five to seven jars were usually used to accommodate all the progeny from a single pair. The preparations ordinarily become sufficiently dry by the time the adults are ready to emerge to enable the operator to anesthetize all the individuals of a culture and then to invert the jar and shake them out.

The above method of handling the cultures can doubtless be greatly improved, very likely to the point where all the progeny can be saved. The greatest loss in the present method comes during the larval period when some of the larvae, especially the younger ones, fail to migrate into the filter paper, and are drowned. The food combination used produces the necessary elements for growth but it has the disadvantage of becoming very fluid soon after the larvae are hatched.

The response to light and to gravity is only a little less marked than in Drosophila. Cultures may be almost completely emptied of adults by placing a funnel over the culture jar, pointing the funnel toward a strong light and agitating the jar.

Following is a typical culture record:

Jan. 31. Several new adults placed in boiled lettuce culture.
Feb. 4. First eggs.
Feb. 6. Many eggs; a few larvae.
Feb. 10. Great numbers of larvae; adults still present; first pupae.
Feb. 14. Many pupae.
Feb. 19. First new adults emerging.
Feb. 22. Many adults; one hundred and sixty-seven to date.

Wilson and Stoll have recently described methods of capturing and rearing several other species of Leptocera and it is likely that series of parallel mutations may be discovered in these different species.

The Mutation and Its Genetics

The cultures were started in December and up to March the culture methods were given attention with the objective of improving them. From forty to two hundred specimens were obtained from each culture. Intensive inbreeding was practiced in the hope of securing mutations and in March two females were observed which had notches at the ends of the wings involving about one-eighth of the total length. The specimens with the defective wings could not fly effectively. The defect was apparently not an accidental one as both wings were affected alike and under close examination the defects took the form of very regular notches (Figure 15*C*). An attempt was made at once to secure a strain of notch winged specimens by isolating the females and inbreeding their progeny but such a pure strain was not obtained. Specimens in the next generation were isolated in the pupal stage so as to insure their virginity and still pure strains could not be obtained. Many variations of the first mutation appeared resembling "Bifid," "Beaded," "Notched" and "Cut" mutations in Drosophila. The simplest variation consisted of a slight scalloping of the costal, terminal or posterior margins of the wings involving in some cases a part of the wing membrane, the vein or only the marginal hairs (Figure 15*E*). In some instances only the anterior margin was affected, leaving the terminal and posterior margins intact. In other instances a well developed terminal notch appeared while the edges were not scalloped. Combinations of scalloping and notching were common (Figure 15*F*). The most radical case of notching removed a full third of the end of the wing (Figure 15*G*). Occasionally a wing would appear with a bent and somewhat thinned costal margin along with other variations (Figure 15*B*). Another variation which appeared only once was a wing which lacked a part

of the posterior half but at the base had a partial reduplication of the wing. Every type of variation which appeared was produced in the bilateral condition.

All attempts to secure pure strains of flies with defective wings failed. Invariably some normal-winged specimens would appear from virgin notched-winged matings, although the notched-winged were always more abundant. Following is a summarized table showing the results of crossing virgin notched-winged pairs:

Parents: Virgin notched-winged males and females..

Progeny:

Culture No.	*Notched*	*Normal*
101 & 101	112	44
104	18	14
105	8	3
106	11	3
200	180	78
202 & 203	188	174
204	52	49
205	14	5
207	2	1
208	83	72
213	12	2
278	50	35
284	17	11
285	68	39
288	87	30
503	20	6
Total	922	566

When normal type was crossed with notched-wing type, both notch-winged and normal winged progeny were produced, the ratio being about six normal to four notched-winged progeny.

Normal offspring of notched-winged parents usually produced only normal-winged progeny. A few such matings produced notch-winged offspring but the possibility of these normal-winged parents having mated with notched-winged specimens previously is great enough to negate the result.

Attempts to separate strains of the notched from the scalloped type of wings by selection were unsuccessful. Because of the variation in the amount of notching and scalloping the possibility of cumulative factors suggested itself but efforts to secure the deeper types of notching by selection were unsuccessful.

From the results obtained so far it is tentatively assumed that the defect described is a dominant one and that it exists only in the heterozygous condition. This is equivalent to proposing that it is linked to a lethal and it is interesting to note that this same variation in Drosophila is also so linked. The mutation occurs in no fixed relation to sex and so is assumed to be an autosomal one. The extreme variability of the mutation may be accounted for by multiple factors or by the fact that several separable characters are present, but not enough information has been secured to warrant any definite statement.

A preliminary examination of the chromosomes in spermatogenesis was made and the diploid number shown to be either six or eight. Should a considerable number of mutations be secured the small number of chromosomes would be favorable for analyzing the genes for distribution upon the chromosomes.

Literature Cited

TURNER, C. L. 1924. Three new Diptera suitable for experimental work in Genetics. *Anat. Rec.* Vol. 29, No. 2, pp. 129-130.

WILSON, J. W. and STOLL, NORMAN B. 1929. Two common fly species easily reared in the laboratory. *Science*, N. S., Vol. LXIX, No. 1796, pp. 571-578.